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RATE REVISION IN MUNICIPAL WORKS.

BY BERTRAM BREWER.

[Read at Convention, September, 1917.]

Those in charge of the business of supplying a community with water are certain to receive frequent queries (perhaps complaints is not too strong a word) from the consumers about both the quality of the water and its cost to them. All inquiries of whatever nature ought always to receive proper attention, but the question of rates especially is deserving of periodical attention. It is another of those hardy perennials, and, like the famous Hartford rose garden at Elizabeth Park, requires frequent investigation and study.

It is a pity that some body of scientific men could not devise a schedule of water rates which in principle at least would apply to all communities making a business of supplying themselves with water. As things stand, however, nearly every works has its own traditions and its own peculiar history, both of which limit the scope of any revision to certain limits.

It goes without saying that every water board or superintendent of water works should be thoroughly well informed as to all the fundamental facts of his system having a bearing on the rates. It is often wise to publish a report of the facts concerning this question for the benefit of consumers, and it is always wise to keep ahead of public discussion of rates and keep the public well informed from time to time of conditions and facts which bear on the subject, so as to guide it if possible toward a sound judg-

ment. A printed report of a study of the rate question was published by the writer in 1915 for the Waltham Water Department, and this outline is offered to show a method of treating the problem in municipal works, with the hope that it may be of use to some one. We also have attempted some general observations in the light of our study and after the experience subsequent to the preparation of the 1915 report.

Rate Fixing in Waltham, Mass.

It was decided at the outset that the period to be forecasted should take in the succeeding five years. The Waltham case was much simplified by the fact that the works are not only municipally owned, but that the city has, fortunately, in the main lived up to the principle that its water works are held by it in trust for the people, and has therefore given the water takers the benefit of any surplus of receipts over expenditures by reducing the cost of water from time to time to those who pay for and use it.

The use of city water for public purposes had for several years been cared for by a charge for all public use of water, except drinking fountains and watering troughs, together with a levy of the nominal sum of five dollars annually for each public hydrant. Supplies for private hydrants and for fire protection purposes have always been furnished free, the owner paying the entire cost of installation. The question of the fairness of this deal from a financial point of view was not considered in the 1915 investigation. It had proved satisfactory to all parties for several years, and the fact that the department has never paid taxes to the city pretty nearly evened up the obligation. With this phase of the question eliminated, and granted that the consumers ought to receive the full benefit of their coöperative venture, the investigation which covered the five years succeeding 1915, and as many preceding years as was necessary to help in forecasting the future, was begun along the following lines:

1. A complete estimate of the reproduction cost of the entire system was made.

2. Figures were prepared to show in detail all expenditures for the preceding five years, classified and tabulated so as to show their relation to future expenditures. A chart was prepared show-

ing the growth of population in Waltham. Other charts were made showing the quantity and quality of the water from year to year for a long period. The Waltham supply is a ground water taken from two large wells near the Charles River.

3. The effect of metering on revenue and consumption was also *especially* studied for the preceding five-year period, as this was a very uncertain element in any estimate of future revenue. Up to 1915 less than forty per cent. of the services were metered.

With all these facts fully investigated and at hand, certain assumptions for the future were made. For one thing, it was assumed that metering would be rapidly continued so as to be entirely completed at the end of the five-year period under consideration, and again that such metering would result in some reduction in the per capita consumption. In 1913 the consumption was 90 gal. per person, with 25 per cent. metered, while in 1916 it was 71, with 53 per cent. metered. We believe that this figure should certainly be cut to 65 by the end of the next five years.

The next step consisted in forecasting probable future expenditures, both ordinary and extraordinary. In Waltham these consisted of the following:

1. Installation of and repairs to services.
2. Operating expenses, pumping, care of real estate, reservoirs, mains, gates, hydrants, etc.
3. Fixed charges.
4. Extension of metered services.
5. Replacement of mains.
6. Higher service for the higher parts of the city.
7. Additions to the collecting works to provide for a larger supply.
8. Extension of mains.

In order to ascertain how much profit or loss the next five years would bring, a careful estimate of income on the basis of existing rates was made. Investigation of past experience seemed to indicate that the income from metered services averaged 90 per cent. of what it had been under fixture rates, and this percentage was used as a basis for estimating that portion of the income as

the fixture rate services should be changed over to metered. The remainder of the estimate was comparatively simple.

The estimate of income consisted of the following items:

1. Income from fixture rate services.
2. Income from existing metered services.
3. Income from existing fixture rate services changed over to metered.
4. Income from new services.
5. Income from a new high-level supply.
6. Income from installation of services, repairs, etc.

Perhaps it would make it clearer to insert at this point the table just as it appeared in the Waltham report, illustrating the results of this particular study as it was expressed in figures for the Waltham City Government.

ESTIMATE OF TOTAL OPERATING EXPENSES, INCLUDING FIXED CHARGES FOR YEARS 1916 TO 1920.

	1916.	1917.	1918.	1919.	1920.
Ordinary operating expenses...	$38 000	$38 500	$39 500	$41 500	$42 000
Meter installations.....	6 000	6 000	6 000	6 000	6 000
Renewals to improve circulation,	2 000	2 000	2 000	2 000	2 000
Extension for high service (fixed charges on $5 0000, 30-year loan).....				5 000	4 880
Additional supply (fixed charges on $21 000, 5-year loan).....	5 840	4 640	4 480	4 320	4 160
Installation of services and repairs.....	5 560	5 651	5 742	5 833	5 924
Fixed charges on existing debt..	24 505	23 795	21 795	13 407	10 362
Fixed charges on an expenditure of $8 000 annually for extending street mains.....		2 320	4 560	6 720	7 800
	$81 905	$82 906	$84 077	$84 780	$83 126
Contingencies, 5 per cent.....	4 095	4 145	4 204	4 239	4 156
	$86 000	$87 051	$88 281	$89 019	$87 282

ESTIMATE OF INCOME FOR YEARS 1916 TO 1920.

	1916.	1917.	1918.	1919.	1920.
Fixture rate services	$38 220	$28 666	$19 111	$9 555	
Present metered service	42 410	42 410	42 410	42 410	$42 410
Present fixture rate services changed to metered, incl. rental	8 585	17 170	25 755	34 340	42 925
New services (metered, including rental)	1 909	3 818	5 726	7 635	9 544
High level supply, new services,				400	450
Installation of services, repairs, etc.	2 873	2 919	2 966	3 012	3 058
	$93 997	$94 983	$95 968	$97 352	$98 387

EXCESS OF ESTIMATED INCOME OVER EXPENSES.

1916.	1917.	1918.	1919.	1920.
$7 997	$7 932	$7 687	$8 333	$11 105

It will be observed that the estimate showed a surplus of income over expenses. Definite recommendations were accordingly made, looking to a small reduction in income. The reductions were intended to apply to certain charges which the water takers found most annoying, as, for instance, an annual charge of 10 per cent. of the cost for the meter and its installation in every case. It was also recommended that the city assume the duty of installing supplementary meters in multi-tenement houses, if the owner would arrange the piping so that all meters could be set near together in one cellar.

The report was not published until 1916, and its recommendations were not carried out until the year was half gone, so their effect was not very apparent up to the end of the financial year 1916. Work on the extension of the supply has not yet been begun. It proved to be a bigger problem than was anticipated, and may cost a large amount of money. All this, together with a large saving in operating expenses, due to a new and business-like administration of affairs, rather upset the estimates, and the department had a larger surplus than was anticipated on January 31 of this year. Just as soon as a definite policy in regard to a more adequate supply can be adopted, it is intended to apply

the elements of the 1915 study to the new conditions and adjust prices accordingly.

Summary and Conclusions.

The question may be asked as to why an estimate of reproduction cost was made in this case, where it was not used in fixing the rates. The answer is that the reproduction cost was a sort of taking account of stock. The city auditor has always carried a statement of the book value of the works on his books from year to year, and it was considered wise to check that up with actual figures of values. There is no better way of ascertaining the correct location of fixtures, exposing the weak spots in office and field organization and obtaining an intelligent and comprehensive knowledge of the business. There are at present no obsolescent fixtures, and depreciation was practically cared for in the estimate of the expenditures for the next five years in several of the items. Further on, the writer has something to say regarding payment of taxes by a municipal business venture such as that of supplying water. If taxes are paid, the reproduction cost of value of the works becomes a vital factor.

An enormous amount of literature has been published relative to rate fixing, much of it very complicated and full of perplexities to the average mind, even among men familiar with water-works administration. The problem in a municipal plant is fortunately comparatively simple — mainly to make the returns commensurate with the expenditures.

We attempted to provide for a period of five years. It is a very difficult task to plan so far ahead. The writer knows of one case at least where provision for a fair return is made by giving the water takers an annual discount. The surplus, if there is any, is returned in this way to them each year, while the rates remain unchanged.

While it is a fact that we would, if making a new study of the rates to-day, follow practically the same general course that we did in 1915, it should be stated that subsequent experience and reflection call for some modifications in the program. In the main, however, the methods adopted in Waltham were simple and direct, and in retrospect seem wise. Here is a basis for further re-

vision which can be followed from time to time as conditions change.

The writer believes that it is only fair and logical for the water department to pay taxes on its property, and also that the city should be charged a fair rate for what water it uses as well as for hydrant service. As a basis, therefore, for rate fixing, he would charge a fair price for everything furnished the city and, in return, hold the water department to a strict accounting for all it receives. He would not, however, provide for a franchise tax. If it had received but $50 per hydrant, the Waltham Water Department could have paid taxes on the value of its plant, and in 1916 would have made a further profit to the department of more than $3 000 on the deal.

Where the works have been paid for and maintained by the consumers, the evil practice of taking water-works earnings for general municipal expenses should be stopped. There should be laws to prevent an improvident city government from using the water taker's money to keep down the tax rate, and so pull some politician's "chestnuts out of the fire." This has been done altogether too often. If municipalities in this country, as now seems probable, are to embark more and more in business enterprises, it is highly important that the use of surplus funds should be well safeguarded.

The great advantage of an attempt to inform the public is, of course, to make clear to all the necessity of looking ahead. Without a careful foresight as to the expenditures which are sure to be required, as well as the probable additional demands, there is always danger that the public may call for the distribution of any surplus which may temporarily accumulate. It is not necessary to emphasize the difficulty in increasing rates to cover a shortage as contrasted with the ease of a reduction. Arguments in favor of a reduction in rates always meet with a favorable reception, and they can be answered the more effectively the more widely the real facts are disseminated. Frequently they are advanced by parties who ought to be fully posted, but who, for reasons of their own, prefer to cater to popular sentiment rather than to use their influence to the real advantages of the public, and appeals such as this cannot be ignored or overlooked with

safety. They can only be offset by a painstaking exposition of the true situation.

One of the most effective of the arguments which are advanced is based upon the feeling that the poor ought to get things as cheaply if not more cheaply than the rich. In Waltham this has gone so far that an ex-mayor is actually advocating in the public prints a rate of one and one-quarter mills per cubic foot for a minimum annual consumption of 4 000 cu. ft., and a rate of one and one-half mills per cu. ft. for a consumption anywhere between this 4 000 and the point where the wholesale rate begins to apply, this in place of the existing rates of two mills and one and one-tenth mills for domestic and wholesale consumption, respectively. This is quite antipodal to the famous Vanderbilt policy, and serves to emphasize the fact that the idea that those who have money must pay the way for those who have little or none is very popular to-day, and that, whatever we may think of it, it has got to be reckoned with.

We sympathize with the industrious poor man, who is raising a family of children or who has raised such a family, many of whom are just now offering their lives to the country. We believe that such men will have more to say about these matters in the future than in the past. We should surely like to have them get their part of the water supply at cost. We sympathize also with the great middle class which seldom complains, does most of the real thinking in the world, and is subjected to a constant grinding between the "upper and nether millstone."

The wholesale user now gets the low price in Waltham and in most other places. He also gets the free fire service. Perhaps this is right to a certain extent, but we must bear in mind that the poor man is becoming fully as important an element in Democracy as his richer brother. It is well, therefore, in America and in these times, for the management to consider this element in municipal service. It is no use to be officially blind to the signs of the times.

The question of relative rates for different services is, however, only a part, though an important part, of the problem. The main question is rather the necessary amount to be charged upon consumers in order to cover cost. This question, the writer main-

tains, can be solved satisfactorily only by careful study of future developments, based upon the lessons of the past. There is no panacea for all the difficulties of rate fixing, but the ideal for which we must strive, namely, a square deal and equal privileges for all, can only be reached when we have acquired sufficient wisdom from experience to decide how long to rest upon established order and when to cut loose and go ahead.

DISCUSSION.

MR. HAROLD K. BARROWS. It is not quite clear to me whether the valuation was based entirely on reproduction cost alone. That is, whether or not Mr. Brewer took into account the element of depreciation in getting at his fixed charges.

MR. BREWER. The reproduction cost was figured on the basis of average prices for materials and labor. It was not used at all as a guide in forecasting future expenditures. In the estimate of future expenses provision was made for renewals, care of the debt, and a considerable item for contingencies was added.

CONTROL OF MICROSCOPIC ORGANISMS IN WATER SUPPLIES.

BY WM. HAINE.

[*Read September 12, 1917.*]

The purpose of this paper is to present a brief, non-technical discussion of the relation of "Microscopic Organisms" to water-supply troubles, more especially to those of New England, and to offer some suggestions that may be of assistance to the water-works man.

Without going into a detailed study of the problem, it may be said that all surface water supplies are more or less susceptible to growths of microscopic organisms, but the optimum conditions for their development are to be found in lakes and reservoirs rather than in running streams. Many New England cities are dependent upon impounding reservoirs for their water supply, and there are few municipalities so situated that have not suffered from the effects of microscopic life. The chief difficulties arising from the presence of these organisms are the tastes and odors which they impart to the water. In order to prevent these tastes and odors, many remedies have been suggested and tried, but prior to the use of copper sulphate none had given general satisfaction. By covering filtered water reservoirs, algæ troubles have been eliminated in the case of filtration plants. This method, however, cannot be used for large reservoirs.

In the control of vegetable growths, the only practical method which has been developed as a result of a study of the problem is the copper sulphate treatment, which was ably described by Dr. George T. Moore and Karl F. Kellerman, of the U. S. Department of Agriculture, in 1904. To Dr. Moore belongs the credit of successfully demonstrating, in 1901, the use of the method in the treatment of watercress beds to eliminate objectionable growths of Spirogyra. The first water supply so treated was the reservoir of the Winchester Water Company, Winchester, Ky., which was contaminated with Anabæna, and the results were

very satisfactory. The treatment is now recognized as a standard procedure in water-works operation, and is simple, consisting essentially of placing weighted quantities of copper sulphate in loosely woven bags and dragging them from the stern of a motorboat. This is preferable to a rowboat, since the movement of the propeller assists materially in spreading the chemical evenly over the surface of the water.

While the services of a technically trained man are not necessarily required for this phase of the work, it is essential that some judgment be used in determining the rate of solution from the bags and controlling the amounts of chemical dissolved in the various parts of the reservoir, in order to get the best distribution. It has been the writer's experience that better results are obtained if slightly larger quantities of the chemical are added to the shallow areas, as the heaviest growths are most frequently found in these localities.

As the amount of chemical required for successful treatment of a supply depends in a large measure upon the types of organisms present, it is necessary to know what types we are dealing with, since some of them are more susceptible to the action of copper sulphate than others. We have found that most uniformly successful results are obtained when the amount of chemical is determined on the basis of the most resistant types of odor-producing organisms in the supply. If the dosage is insufficient to kill the more resistant forms, secondary growths develop which also produce trouble. Scientific studies of the amount of copper sulphate necessary for killing various organisms may be found in the literature on this subject, and the results of practical treatment coincide very closely with the figures thus recorded.

In this connection, the most common mistake of the water-works man is to defer action until the growths have developed to such an extent that the consumers object. The treatment produces best results when used as a preventive measure rather than as a cure, therefore it is highly advisable to treat promptly at the first sign of a decided increase of odor-producing algæ. This information can be obtained only by microscopic examinations made at regular intervals, especially during the time when trouble is to be expected. In this way, the odor-producing or-

ganisms are detected at their first appearance, and prompt treatment destroys them before the consumers are aware of any possible difficulty. Although the method is undoubtedly efficient under proper control, it cannot be emphasized too strongly that a definite knowledge of the condition of the reservoir is always required, if uniformly successful results are to be obtained.

In some instances, subsequent to the treatment of a supply, large numbers of fish have died, and for this reason numerous researches have been carried out to determine the tolerance of various types of fish to copper sulphate. It has been shown that trout can be killed with .14 parts per million of copper sulphate, while black bass are able to withstand up to 2.10 parts per million, and other species range between these limits.

A phase of the problem that has not been emphasized, however, is the effect of the reduction of the dissolved oxygen in the water following copper sulphate treatment. Laboratory tests of water after treatment show a material reduction in the numbers and types of algæ with rapid increases in the numbers of bacteria, and accompanying these changes the dissolved oxygen in the water is very materially reduced. This change is due to the bacterial activity involving the oxidation of decomposing algæ growths.

Our records, covering a great many copper sulphate treatments, show that there has been no destruction of fish life in the cases where the treatment was given before the growths had developed to any great extent. In many cases the amount of copper sulphate used was greater than that given in the literature as sufficient to kill certain types of fish which were present.

There are numerous records to show that great numbers of fish have been killed as a result of the sudden reduction of the dissolved oxygen content of reservoirs and lakes, following the destruction of heavy growths of algæ by marked changes in weather conditions. This trouble was experienced by one of our Connecticut cities during May of this year, and twelve barrels of fish were taken from the supply. Another instance was reported in Flushing, N. Y., where two hundred carp and a number of perch were killed in Lake Kissena. Sensational reports were circulated to the effect that the fish had been poisoned, but an

investigation conducted by a chemist of the New York Water Department brought out the fact that the death of the fish was due, not to any poisonous foreign substance in the water, but rather to a lack of oxygen. Similar conditions have been reported in Massachusetts, New Jersey, and in other states, where copper sulphate had not been used. In the writer's opinion, many instances where large numbers of fish have been killed following copper sulphate treatment, the difficulty has been due to the sudden destruction of large volumes of vegetable growths rather than to any direct poisonous effects of the chemical.

It has been asserted that anything which would destroy fish would be harmful to man, and there are some who object to the treatment on these grounds. Authorities are agreed, however, that copper sulphate as it is ordinarily applied in ridding supplies of microscopic organisms does not endanger public health. The fact that many cities throughout the country have been getting relief for a number of years by the use of the treatment without any evident adverse effects is a good indication that the method is not a dangerous one and merits the attention of any municipality where objectionable types of algæ exist in the water supply.

Discussion.

Mr. W. A. McKenzie.* I should like to ask the speaker what he means by the size of the reservoir, — whether he means the area or takes into account the depth. And what is the maximum amount of copper sulphate which can be used in a reservoir and permit the water to be used by a town? You stated that up to certain sizes of reservoirs it was practicable to use copper sulphate. I have in mind our own reservoir, which covers some 160 acres, with an average depth of about 30 ft., and a capacity of about one billion and a quarter gallons which we treat with success. In other words, where do you draw the line?

Mr. Haine. I think you misunderstood my statement. I referred, in the case of smaller reservoirs, to the fact that it might be feasible to cover them, whereas we treat any sized body of water with copper sulphate. Regarding the maximum amount

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of copper sulphate used, as stated in the paper, we base the dose upon the most resistant odor-producing type present, and usually it has not taken over three-tenths of a part per million of copper sulphate to clear up the supply in very good shape. There have been instances, possibly, where we have used slightly more. But ordinarily .2 or .3 of a part per million is the average dose, depending upon the organisms present.

MR. FRANK L. FULLER.* I should like to inquire of the speaker whether, if the algæ were entirely removed from any reservoir, you would get a repetition of the growth the next year; and if so, where the algæ would come from.

MR. HAINE. The growth in a reservoir under such conditions would be due to algæ carried into the supply from swamps in the drainage areas during spring freshets and early rains. It is not known definitely just what determines the extent of a growth of algæ in a reservoir. Some years there will be a heavy growth in a reservoir, and then it may run along for ten or twelve years before there is another heavy growth. Although we are not certain just what are the governing conditions in that case, yet warm weather, intermittent rains, flushing swamp growths into the supply, and similar factors have an important bearing on the extent of the reservoir growths. The destruction of algæ in the reservoir, therefore, is only effective for the water then in storage.

MR. FULLER. When the algæ are killed by the chemical, it goes to the bottom, I suppose. And does it not decompose and still make trouble?

MR. HAINE. The increases in numbers of bacteria are, of course, kept at a minimum if copper sulphate treatment is applied before the algæ growths have reached a high state of development, as the numbers of bacteria increase in proportion to the food supplied by the destruction of the algæ.

The copper sulphate exerts a poisonous effect on the algæ so that the organisms are precipitated as dead organic matter and food for bacteria. The bacteria which are always present decompose the dead algæ and multiply in large numbers during the process. These sudden increases in bacterial counts are noticed not only after copper sulphate treatment but also after sudden

* Civil Engineer, Boston, Mass.

destruction of algæ growths in the fall, when cold weather adversely affects their development.

As the bacterial oxidation of the dead algæ reduces the dissolved oxygen in the water, early treatment of the supply tends to eliminate the danger of killing fish as a result of depletion of oxygen in the water.

MR. FULLER. Does the copper sulphate have any effect upon the bacteria?

MR. HAINE. Copper sulphate has a slight bactericidal action. When used in large enough quantities, it is a germicide. It has been used for sterilizing the water. I have in mind one instance where copper sulphate was used to the extent of one part per million to sterilize the water in place of chlorine gas. But in the proportion used in algæ treatment it has no appreciable bactericidal action.

A MEMBER. I might inquire, in figuring the quantity of water to be treated, if you figure the total capacity of the reservoir, or take 6, 8, 10, or 15 feet on the top. What is your custom?

MR. HAINE. Our custom is to figure the capacity of the reservoir as near as we can estimate it. In treatment, however, we distribute somewhat larger proportions of chemical over the shallow areas where the growths are usually heavy.

A MEMBER. The speaker has suggested that it is better to treat the water as a precautionary measure when the microscopic growth is first observable. All the growth is not algæ, but we hear more about algæ because it is a common growth in our open reservoirs. In our case we use underground water stored in a cement reservoir, and every year we get a growth of Cypris. I should like to ask the speaker's opinion as to whether the best time is to treat the water when the growth is first observable, no matter how minutely, or to wait until the organisms have more fully developed.

MR. HAINE. It is a general principle in the treatment of algæ or microscopic organisms, to treat the supply as soon as the organisms have developed in sufficient numbers so that they might become objectionable. In your case, more permanent results would be obtained by covering the reservoir, as stored ground waters are especially liable to develop heavy growths of algæ.

A MEMBER. Heretofore we have waited until the growth was quite pronounced, although it had not reached an objectionable stage, and then treated it with good results. But I wondered whether, as a precautionary measure, it might be treated as soon as it was observable at all. I had that question rise in my mind a year or two ago, and I didn't want to wait for them to develop.

MR. HAINE. Undoubtedly it would do no harm, and if it would check that growth before it had got practically any start it might save trouble, for there may come a time when you will not check it soon enough.

MR. FULLER. In Wellesley, Mass., we have always had a ground-water supply, and originally it was pumped into an open reservoir, and we were obliged to clean out that reservoir almost every year, and in the bottom we would find a greenish substance which I supposed was the microscopic organisms of sea moss. Those would be removed and the water would be pumped into the reservoir again, and for a few days it would be perfectly clear and you could almost see the bottom — I don't think through the entire depth, which was perhaps twenty feet, but it would be very clear; but in a few days it would become cloudy, and you could only see perhaps through two or three feet of the water, the reason, I suppose, being the start of the growth of microscopic organisms of one kind or another. Now, I don't see where the origin of those organisms came from. They were not in the ground; they did not come with the ground water; they must have come in in some other way, I presume. Yet this reservoir was on a hill, and I never could exactly account for their presence in the water. Later we covered that same reservoir with an arched roof, and now we have no trouble at all, and it is not necessary to clean out the reservoir scarcely ever. If we should draw off the reservoir we find practically nothing on the bottom. I do not exactly see where those organisms came from.

MR. HAINE. It is pretty hard to state where they might have come from, for when you consider the small space occupied by an organism, there could be a great many organisms in the reservoir even after it had had a thorough cleaning, unless there were special means taken to sterilize or kill the organisms. Had you used copper sulphate in a fairly strong solution, and let it stand

for some time, and then cleaned out your reservoir, you would probably have eliminated the trouble, for some time at least. There is, of course, the possibility of straw and grass being carried by birds from swamp areas and dropped as they pass over the reservoir. If these particles were wet and coated with microorganisms, it is quite probable that growths would develop in the reservoir.

MR. FULLER. You mean, before we covered it?

MR. HAINE. Yes.

MR. FULLER. I suppose the covering prevented the presence of light, and that prevented their germinating.

MR. HAINE. To almost all microscopic organisms, sunlight is absolutely essential, for by the action of sunlight they take up their food, and if you take away the sunlight they do not develop.

A MEMBER. Is there any means but sulphate of copper to get rid of these organisms?

MR. HAINE. The only practical means that have been discovered are either copper sulphate or protection from sunlight.

A MEMBER. We have used hypochlorite with great success.

MR. HAINE. Hypochlorite has been tried but has not proven satisfactory.

A MEMBER. It is safer, isn't it, than bisulphate of copper which you have to use with greater care? The hypochlorite will assimilate more quickly through the body of water. Now, I am speaking from experience.

MR. HAINE. Yes, I appreciate that. How have you distributed your chloride of lime?

A MEMBER. I went through with a rowboat and distributed it so much to the gallon, through the reservoir, with good results. The people noticed the change in the water.

A MEMBER. The point I wish to bring out is, if you use the bisulphate of copper you will kill the fish, and what will kill the fish will hurt the people.

A MEMBER. I understand that some organisms require five times as much bisulphate of copper as others. I was wondering what organism it did not kill. Cypris is very difficult to destroy.

A MEMBER. It seems to me, to get at the source of this trouble — the drainage areas — would accomplish a great deal and would

not require treating nearly as much. In our own case, we had a reservoir of 1 250 000 000 gal. that, previous to clearing up the swamp, cutting the brush, and keeping the brush cut so that our swamp areas were drained out, required about .4 of a pound per million gallons, which is now cut down to between .2 and .2¼ lb. per million gallons. By treating when there is a breeze blowing from one end to the other we get very much better results and accomplish it very quickly. We have never killed any fish, and have run up to .4, and a little over. And another place in New Jersey there is a large lake, where there is trouble with a growth of lily pads and vegetation. Copper sulphate was spread around in these growths and it was found that instead of being obliged to cut that off, the vegetable growth would die, break off at the root at the bottom of the lake and float down the stream. It saved a good deal of hard work, as it was not necessary to cut out the vegetable growth in the shallow area of the pond.

MR. W. C. HAWLEY.* I am a little surprised at the statement that trout will be killed by such a small dose. I have put it in a reservoir containing many trout without killing any of them. I don't think we want to worry very much about the effect of the copper sulphate any one can get out of the water. We get more copper sulphate out of a dish of French peas or beans, where it has been used as coloring matter, than we would get out of a barrel of water.

MR. HAROLD K. BARROWS.† I should like to ask the speaker what his experience has indicated in regard to the effect of drawing down a reservoir, more particularly a natural pond, on the tendency for the algæ growth. What I have particularly in mind is, perhaps, a pond which in dry periods of the year may be drawn down to a considerable extent and the shores exposed in such a way that vegetation is likely to grow for a time. Has his experience indicated that this is likely to result in an increased growth of the algæ?

MR. HAINE. Lowering the water level of your reservoir allows for the growth of vegetation on the exposed bottom, and when

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† Consulting Engineer, Boston.

this is covered, it produced, during decomposition, food material for the development of algæ carried into the supply from the drainage area.

MR. BARROWS. If I might add just a word, what I had in mind particularly was shallow areas. When these are drawn down to such an extent that a very considerable part of its area is shallow, — is that likely to result in an increased growth of algæ?

MR. HAINE. Yes, for the reason just stated.

MR. FULLER. The supply at Ware, Mass., is very similar to the supply at Wellesley. It is a ground-water supply, and the reservoirs are almost exactly the same size and similarly situated. Now, I think that Ware has never had any trouble at all with any growth of microscopic organisms. They have never covered the reservoir, which was built in 1886, and, although the reservoir has been cleaned from time to time, I think they have never had any such cleanings as we have had at Wellesley. This seems to be an interesting matter because I think in New England, at the present time, there are not many reservoirs containing ground water that are not covered. A great many of them have been covered.

MR. WALTER H. RICHARDS.* Just one thing that has been drawn out here to-night occurs to me. I have watched this thing now ever since they discovered that there was such a thing as algæ, certainly, because I still remember when they told us it came from vegetation. Everybody said so. In fact, they had not discovered these microscopic growths at all. And it occurred to me that until you find out where they come from and what makes them grow, you are working in the dark continually, and it seems to me that the bacteriologists have had most time enough now. They have spent about twenty-five years at it, and it is about time that they told us where they come from, and then we will know ourselves how to get rid of them.

MR. P. J. CONLON.† We are in the highest part of Massachusetts, at North Adams. About five or six years ago the superintendent at Williamstown came to me and said, " Your water was

* Engineer and Superintendent, Water and Sewer Department, New London, Conn.
† Superintendent Water Department, North Adams, Mass.

bad last year." I answered, "Yes, it was." He said, "Come over and see what you can do for us," which I did. The water came out of a rock in the mountain. We treated the water without advice of a chemist or any one else, with results very satisfactory to the superintendent at Williamstown. But I didn't tell what I did to it. The method used I had seen described in the *Engineering News*. I gave it the same treatment we have been talking about, — hypochlorite of lime. But that is not surface water; it is from the highest pond in the state of Massachusetts. Now, there you are with your hypochlorite of lime and your bisulphate. I used 8 lb. to the million gallons, and I think the reservoir is clean.

Our water comes from the surface. The Williamstown water comes from the mountain, right out of the rock, in a 6-in. stream, and it doesn't touch any land at all.

MR. HAINE. If the ground water is stored on the surface, sunlight should be eliminated by covering the reservoir or algæ control is likely to be necessary.

MR. HOMER R. TURNER. I should like to ask in regard to these pond or stagnant waters of lagoons. If it were impossible to drain them, could an alternative method be devised by putting a dike between the reservoir and the stagnant area to prevent the water getting into the reservoir, except by filtration through the dike, which would help in reducing the chance of algæ?

MR. HAINE. Yes, that undoubtedly would assist for a time, but the filter banks are likely to clog. There was a paper read last year before the American Water Works Association by people in charge of water supply at St. Paul, Minnesota, and in that instance they recommended the treatment of small lagoons and small swamp areas with copper sulphate by means of a spray pump.

SOME METHODS AND RESULTS OF FILTRATION AT PROVIDENCE WATER WORKS.

BY FRANK L. CADY.*

[*Read September 13, 1917.*]

The filters of the Providence Water Works are located at Pettaconset, on the Warwick side of the Pawtuxet River, opposite the main pumping station, which is in Cranston.

FIG. 1. A GENERAL VIEW OF FILTERS FROM TOWER OF PUMPING STATION.

The supply of water is taken from the Pawtuxet River about four miles above the village of Pawtuxet, which is at the mouth of the river, and about seven miles from the center of Providence. The watershed of the river above Pettaconset contains about one hundred and ninety-six square miles. An estimated popu-

* Bacteriologist with the City of Providence at the Pettaconset Pumping Station.

lation of about 31 000 lives on this watershed, mostly concentrated in seventeen mill villages within nine miles of the filtration plant.

The plant in November, 1905, when first put in operation,

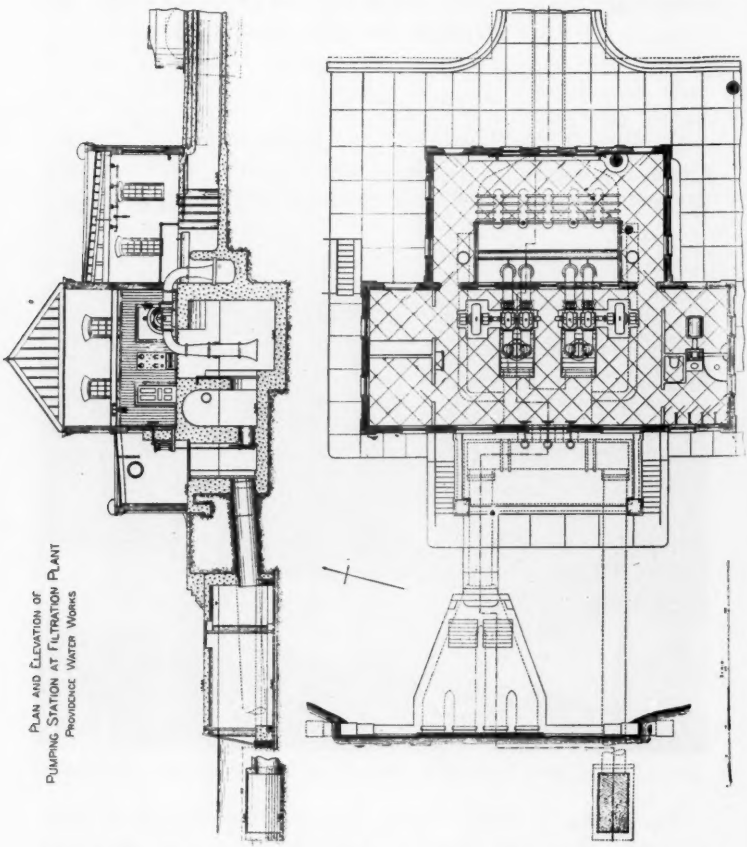

FIG. 2.

consisted of six open filters of one acre each, with two more in process of construction. One of these was later put in operation as an open filter. After the first winter, it was decided to cover all beds and to build two more filters, making ten in all, each,

when covered, containing .98 acres. The winter of 1906–7 was very severe, and the expense of removing ice from the beds proved the necessity for covers.

The pumping plant, which lifts the water from the river on to the filters, is at the edge of the river, about 1 200 ft. above the old intake at the Pettaconset Pumping Station. The water is lifted by the De Laval centrifugal pumps, driven by direct-connected electric motors, arranged in duplicate, each unit with a capacity of 20 000 000 gal. per day with a 7-ft. lift.

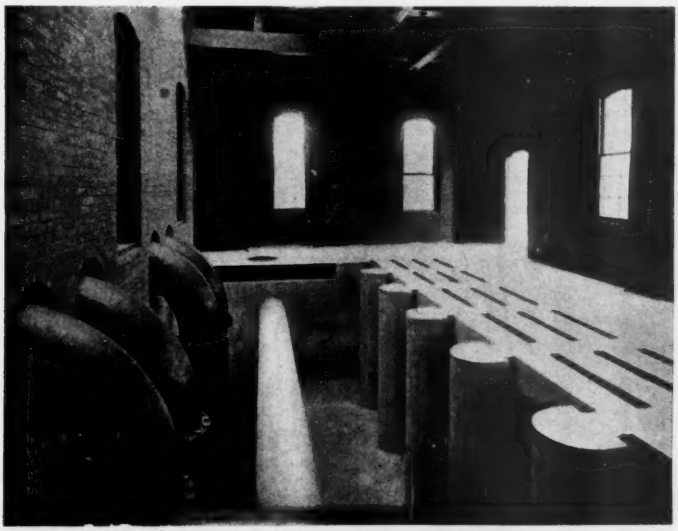

FIG. 3. INTERIOR VIEW OF SCREEN CHAMBER.

There are two intakes; one, a horizontal grating slightly above the bed of the river; the other, a vertical grating at the shore line.

On being discharged from the pumps, the water passes over a stilling weir through a series of screens having 5, 6, 10, and 24 wires to the inch. Every screen can easily be raised by a traveling hoist, to be cleansed by a stream of water from hose nozzle, because the net area of the waterway is at least twice the cross-section of the conduit.

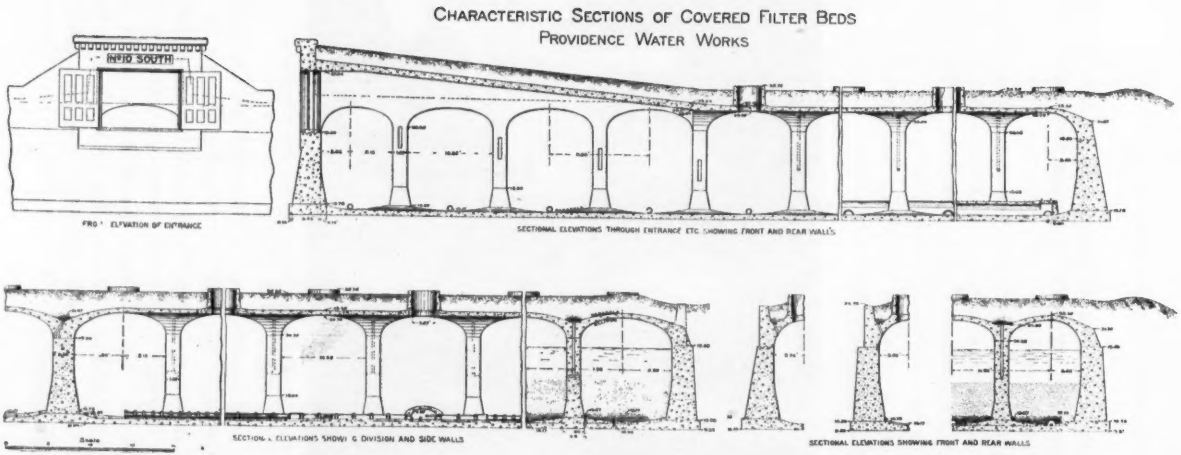
CHARACTERISTIC SECTIONS OF COVERED FILTER BEDS
PROVIDENCE WATER WORKS
No 10 SOUTH
SECTIONAL ELEVATIONS THROUGH ENTRANCE ETC. SHOWING FRONT AND REAR WALLS
SECTIONAL ELEVATIONS SHOWING DIVISION AND SIDE WALLS
SECTIONAL ELEVATIONS SHOWING FRONT AND REAR WALLS

FIG. 4.

SECTIONAL PLAN AND ELEVATIONS OF COVERED FILTER BEDS
PROVIDENCE R I WATER WORKS

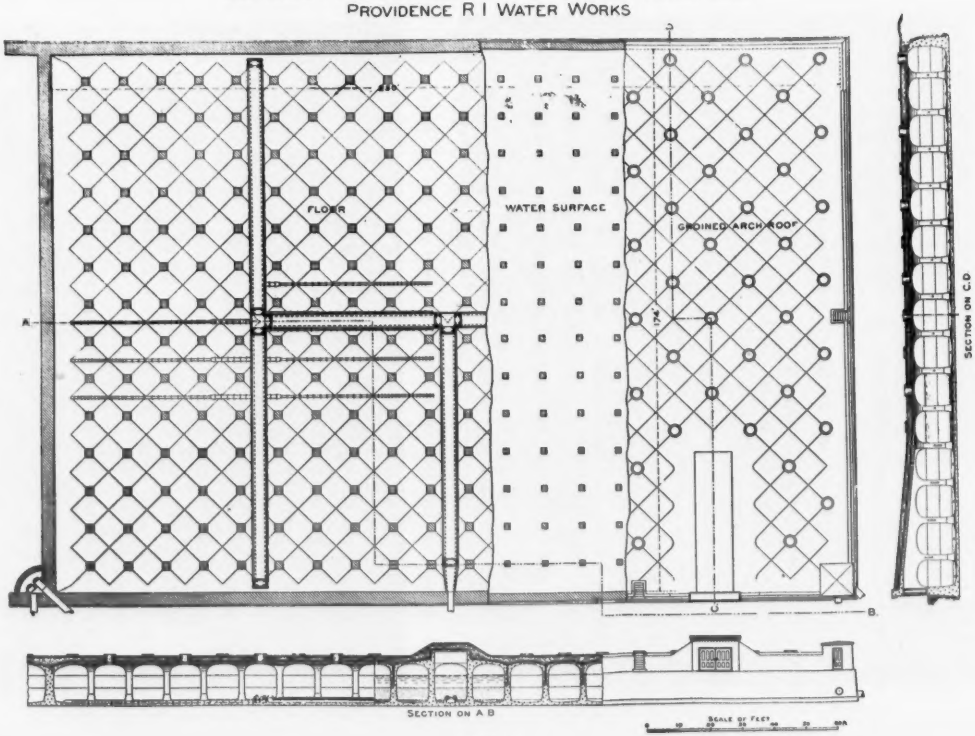

FIG. 5.

The water flows in conduits of concrete and vitrified pipe to the filters, entering each by means of a 24-in. gate and flooding the sand to a depth of 4 ft. The 24-in. waste gate and overflow are also located in the same gatehouse.

Each filter consists of a concrete tank, 9 ft. in depth and 1 acre in area. The cover consists of groined vaulting supported by 20-in. concrete pillars 12 ft. from center to center. The filtering material consists of 4 ft. of sand on 1 ft. of gravel.

Within the gravel layer is placed the underdrain system. The pipe drains are laid upon the floor, completely covered with gravel, and consist of 6-in. circular and 12-in. split vitrified pipe, laid with $\frac{3}{4}$-in. open joints. These enter into the main drains of vitrified pipe or reinforced concrete. The main drains receive water from four groups of laterals arranged in the manner shown in plate. These main collectors are arranged in this manner in order that the rate of filtration may be more nearly uniform over the whole area of the bed.

The filter sand, obtained within one-half mile of plant, has an effective size of .34 and an uniformity coefficient of 2.5. The gravel is laid in three layers, the first being 7 in. in depth and between 1 in. and 2 in. in diameter, the second $2\frac{1}{2}$ in. in depth and between $\frac{3}{8}$ in. and 1 in. in diameter, and the third $2\frac{1}{2}$ in. in depth and varying between $\frac{3}{8}$ in. and a sand coarser than the filter sand.

The following views illustrate the construction of the underdrain and the main collectors, also the placing of gravel and sand within the filters.

The beds, five on each side, face each other on opposite sides of the main court, which is 100 ft. wide. In this court are the raw water conduits, filtered water conduits, pressure water pipes, etc. An 8-in. water main extends the length of this court, supplying water for washing, transporting sand, etc. The regulator houses are also located within this court, one in the center of a group of six beds, and the other in a group of four beds.

The water, after passing down through the sand, flows through drains and collector pipes into the control chambers in the regulator house, there being a chamber for each filter. These chambers have 20-in. inlet and outlet gates, by means of which the rate of flow is controlled. Just outside the regulator house, on

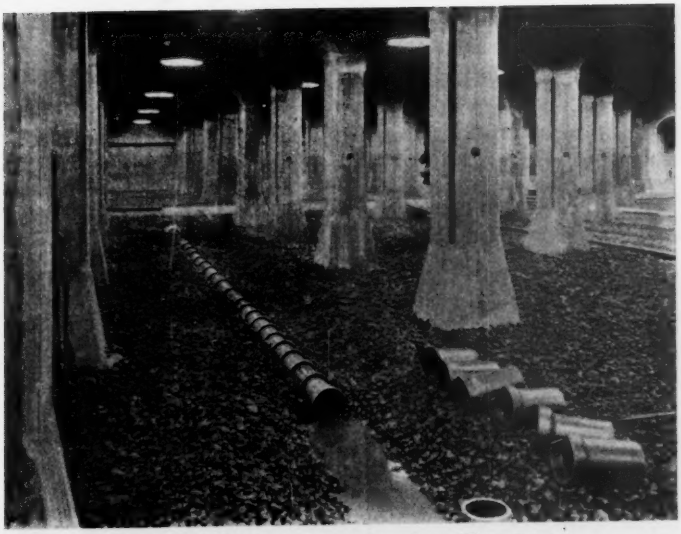

FIG. 6. INTERIOR OF FILTERS SHOWING UNDERDRAIN.

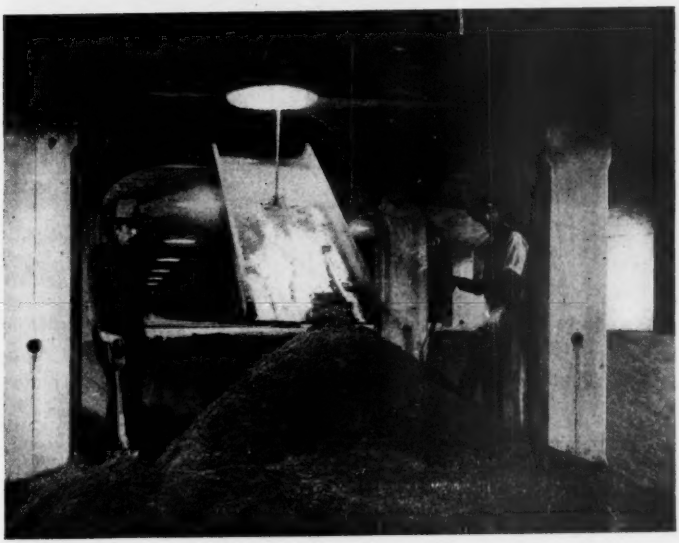

FIG. 7. DEPOSITING SAND IN FILTERS.

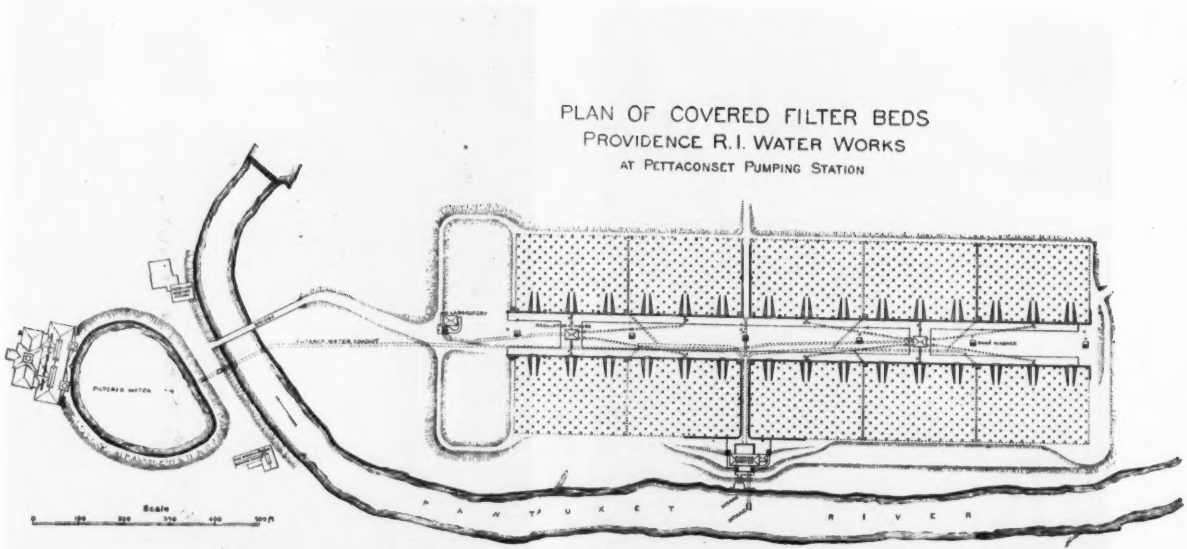
PLAN OF COVERED FILTER BEDS
PROVIDENCE R.I. WATER WORKS
AT PETTACONSET PUMPING STATION
PAWTUXET
RIVER

FIG. 8.

the line from each filter, is a Venturi meter, coming from which are two lead-lined pipes connected with float-tubes in the house. Fine wires connect these floats with an indicating apparatus. A third tube is connected by means of a lead-lined pipe with the raw water on the sand, and also with the indicating apparatus upon which the rate of flow and loss of head are read. There is no automatic control, everything being done manually. The readings are taken at four-hour periods.

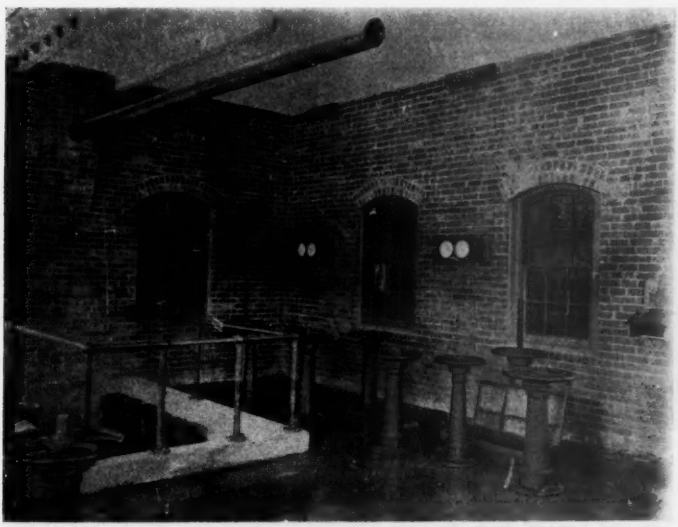

FIG. 9. INTERIOR VIEW OF REGULATOR HOUSE. SHOWING FLOAT-TUBES, REGULATING APPARATUS, ETC.

Besides these gates mentioned, there are 20-in. gates that connect the different filter chambers together in order that each bed when cleaned may be filled to above the surface of the sand with filtered water before admitting the river water.

The 30-in. filtered water conduits leading from each regulator house unite in a 48-in. conduit, which passes beneath the river into the basin at the Pettaconset Pumping Station. The water

is pumped from this basin into the Sockanosset Reservoir, the main distributing reservoir of the system.

In cleaning an uncovered bed, the dirty sand was scraped or skimmed with a square-ended long-handled shovel into windrows running across the bed from front to rear.

A continuous line of wheelbarrows was run around by these, filled by the men shoveling, and dumped in piles in the center court. This method took about three hundred man-hours.

FIG. 10. WHEELING SAND.

After the beds were covered, the method of cleaning was changed. The dirty sand was piled in the beds instead of being windrows, to maintain the surface of the sand more evenly, and the wheelbarrows were run in, stopped, and after being filled run out into court.

This method takes about one hundred and thirty man-hours in summer, and about one hundred and fifty in winter.

The sand within the court is washed and replaced once a year. It is shoveled into portable ejector boxes and conveyed by water, through hose and wrought-iron pipes, to washers.

These washers are of the same type as those used in Washington, D. C. They consist of two iron hoppers, into the first of which

the dirty sand and water are discharged, the water passing over a lip into a settling tank, while the sand passes down against an upward flowing stream of water to the bottom of the hopper. The sand is then ejected from the bottom of the first hopper into the second, where the process is repeated.

The sand ejected from the second hopper is transported by means of wrought-iron pipe and hose on to the tops of the filters into a third hopper, where the dirty water is separated from the

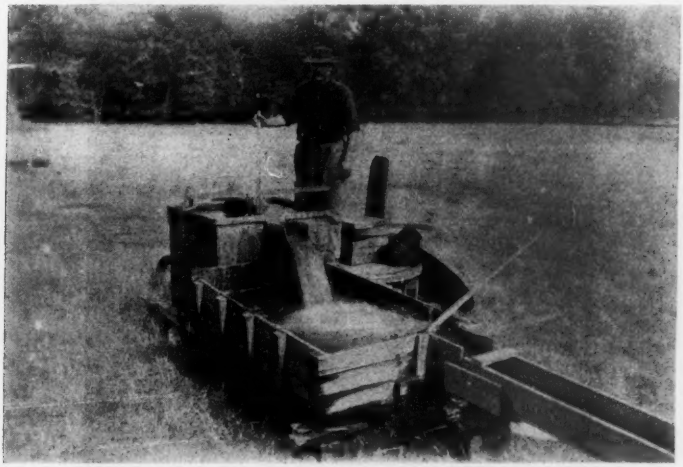

FIG. 11. VIEW OF THIRD HOPPER AND BAFFLE BOX.

sand, and the latter discharged from the bottom of the hopper through a manhole, where it is distributed by means of movable troughs over the surface of the bed by the men. The dirty water passes from the third hopper into a baffle box, where any fine sand passing over may be caught and returned.

Previous to replacing sand, after the bed is cleaned the stained sand extending from the surface down varying depths, usually about 6 in., is thrown back in sections. The washed sand is replaced in each section and the stained dirty sand replaced again on top. This method allows the bed to regain its efficiency more quickly than when the clean sand was placed on top. This method

was continued from 1909 up to the present year, 1917, when a change had to be made, as subsurface compaction, which had shown up first in 1915, had become so bad that it was necessary to remove the sand to below the compacted layer, which was 16 in. deep in some places.

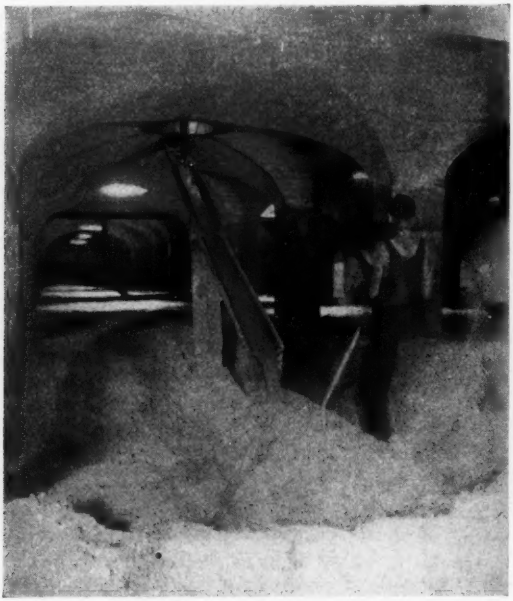

FIG. 12. ILLUSTRATING THE USE OF MOVABLE TROUGHS IN DISTRIBUTING SAND FROM THE THIRD HOPPER, ON TOP OF THE BED, OVER THE SURFACE OF THE FILTER.

The water pressure delivered in the main court would not permit of economical transportation of sand from the filters, as it was only 65 lb. static. By the introduction of a "booster" pump, the pressure has been raised to 150 lb. static, giving a working of over 115 lb. A new system of piping was introduced into the filters also, one line for water, another for ejecting the sand.

With the old pressure of 65 lb. static, about $7\frac{1}{2}$ cu. yd. per ejector-hour of sand could be replaced from the piles in the court; 20 cu. yd. have been replaced from the pile per ejector-hour, with a pressure of 150 lb. static. The pressure was increased at first to 125 lb. static, which gave a fluctuating working pressure of between 70 and 90 lb., while after increasing to 150 lb. static, the working pressure is between 107 and 118 lb.

SOME STATISTICS OF SAND WASHING.

Number of Bed.	Ejector Hours.	Depth of Sand.			Cubic Yards Replaced.	Cubic Yards per Ejector Hour.	Water used to Clean Sand in Gallons.	Gallons per Ejector Hour.	Remarks.
		Removed from Bed in Inches.	Replaced from Sand Pile in Inches.	Total Replaced in Inches.					
4	607.	16	16	32	4 288	7.06	2 154 152	3 549	Washed with static pressure of 125 lb.
6	590.5	14	12	26	3 484	5.90	7 834 976	13 268	
2	360.5	12	8	20	2 680	7.43	5 003 856	13 880	
1	312.5	13	11	24	3 216	10.29	4 889 456	15 646	Washed with static pressure of 150 lb.
10	328.5	12	15	27	3 618	11.01	5 413 408	16 479	

With a pressure of 85 lb. the nozzles in the ejector boxes were about $\frac{11}{16}$ in. in diameter with $1\frac{1}{4}$-in. throat, while with a pressure of 100 lb. or over the nozzles had to be reduced to $\frac{9}{16}$ in. diameter with the same throat. The nozzles in the washers are $\frac{3}{8}$ in. in diameter in the first hopper, used to eject sand from the first to the second hopper, while that in the second, used to transport sand from the washer to the top of the bed, is $\frac{11}{16}$ in. in diameter. Through the necessity of completing the washing of the extra sand as quickly as possible, four or five ejectors, some from the pile and some from inside of the bed, have been connected with either two or three washers. Time is saved by using four discharge hoppers on top of beds, two at a time, the other two being moved to the next set-up. About twenty minutes is saved on each set-up.

The improvement obtained by use of filters has been marked.

The river water, acting as a main drainage channel from the densely populated mill villages, has a rather high color, normally about 45, and rarely exceeding 70. The average reduction in color by means of sand is about 35 per cent. The number of bacteria in the water is not very high, normally ranging from 50 per c.c. to 25 000 per c.c., the higher number showing only after heavy storms. The average is about 1 500 per c.c.

The presence of B. coli in the river water is constant down to $\frac{1}{10}$ c.c., and many times showing in $\frac{1}{100}$ c.c., while it is rarely found in less than 10 c.c. in the filtered water, except after replacing the sand, when, for a few days, B. coli may be found in 1 c.c.

Typhoid fever was not prevalent in Providence previous to the installation of the filters, — at least epidemics could not be traced to the water supply, — so no figures can be given showing any reduction through the use of filtered water.

The following series of tables is given, showing statistics of the operation of the beds and results of filtration.

QUANTITY OF WATER FILTERED BETWEEN SCRAPINGS IN GALLONS FOR 1916.

No. of Filter.	Maximum.	Minimum.	Average.	Average Maximum Loss of Head in Feet.
1	111 540 000	15 370 000	38 200 000	4.20
2	129 160 000	21 470 000	47 080 000	4.29
3	81 280 000	20 660 000	36 110 000	4.42
4	122 580 000	22 470 000	40 850 000	4.29
5	66 240 000	19 510 000	35 890 000	4.30
6	94 730 000	7 590 000	38 350 000	4.36
7	90 440 000	17 510 000	43 340 000	4.32
8	103 720 000	18 700 000	41 450 000	4.39
9	76 480 000	3 320 000	38 890 000	4.30
10	97 930 000	21 200 000	40 050 000	4.31
Whole Plant	129 160 000	3 320 000	40 020 000	4.32

Monthly Averages of Bacteria per Cubic Centimeter.
(24-Hour Counts on Standard Agar at 37½° C.)
1916.

Months.	River Water.			Filtered Water.			Average Per Cent of Bacteria Remaining.	B. Coli in Filtered Water.			B. Coli in River Water.				
									No. Times Present.			No. Times Present.			
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.		Times Tested per Month.	1 C.C.	10 C.C.	Times Tested per Month.	1/10 C.C.	1/5 C.C.	1 C.C.	10 C.C.
January	1 100	100	550	79	4	13	3.2	21	0	16	21	0	21	21	21
February	1 700	200	550	33	3	12	2.7	15	0	6	15	0	15	15	15
March	700	100	350	17	1	6	2.2	18	0	10	18	1	18	18	18
April	700	200	450	11	1	6	1.5	21	0	0	21	2	21	21	21
May	3 200	300	1 300	20	2	7	0.7	19	0	13	19	0	19	19	19
June	2 200	1 000	1 500	27	2	8	0.5	20	0	17	20	10	20	20	20
July	3 000	1 200	2 000	30	3	8	0.4	19	1	18	19	0	19	19	19
August	2 100	900	1 300	23	2	7	0.5	23	1	12	23	1	23	23	23
September	9 000	1 300	3 000	30	3	8	0.3	21	0	16	21	0	21	21	21
October	2 100	300	1 300	41	3	8	0.7	23	0	9	23	8	23	23	23
November	2 300	600	1 500	21	3	9	0.7	22	0	15	22	2	22	22	22
December	3 100	300	1 300	23	5	12	1.5	19	0	5	19	0	19	19	19
Average of Plant			1 250*			9*	1.3*								

*Average of total number of samples taken in year.

Providence Water Works. Annual Statistics.

Year.	Bacteria per C.C. 48-Hour Count, Standard Gelatine.							Average Color Platinum Scale.			Average Number of Cleanings per Bed.	Length of Run in Days.			Yield between Cleanings. Million Gallons.			Average Rate per Bed per Day in M. G.	Average Maximum Loss of Head in Feet.	Cost of Filtration per Million Gallons.			Estimated Population Supplied.	Consumption.		
	Raw Water.			Filtered Water.			% Removed.	Raw Water.	Filtered Water	% Removed.		Max.	Min.	Av.	Max.	Min	Av.			Pump.	Filter.	Total.		Million Gallons		Av. Daily per Capita Gal.
	Max.	Min.	Av.	Max.	Min.	Av.																		Total Yearly.	Average Daily.	
1906	7 500	200	1 470	264	2	25	97.3	..	..	30	13.6	50.9	8	22.4	121 255	26 339	48 156	2.24	4.0	$3.00	$1.99	$4.99	219 800	5 492	15 045	68
1907	8 000	120	1 030	271	1	16	98.0	54	35	35	15.0	56.0	11.5	23.0	140 428	22 566	54 839	2.37	4.9	3.28	4.20	7.48	225 700	5 923	16 227	72
1908	9 000	100	1 200	300	1	16	97.8	43	27	35	12.0	72.9	11.8	25.2	161 704	23 940	55 139	2.08	5.3	3.48	2.03	5.51	231 900	5 693	15 555	67
1909	2 000	150	1 930	1 500	1	31	97.5	46	30	35	13.6	61.5	10.4	23.7	115 595	15 620	40 686	1.72	4.9	3.23	2.05	5.28	237 200	5 532	15 156	64
*1910	25 000	100	2 490	1 200	1	41	98.3	48	33	31	18.0	84.3	6	18.8	142 324	10 312	33 772	1.73	4.8	3.20	1.78	4.98	246 000	5 684	15 572	63
1911	8 000	100	1 350	200	1	13	98.6	48	33	30	14.1	61.7	8	23.7	117 345	14 396	42 755	1.72	4.3	2.98	1.59	4.57	254 100	6 055	16 590	65
1912	18 000	100	1 010	350	1	11	97.9	45	31	31	15.5	51.4	9.5	22.2	108 100	18 310	42 636	1.92	4.2	2.72	1.56	4.28	260 600	6 463	17 660	68
1913	10 000	100	1 500	150	1	10	98.4	46	32	30	16.8	47.7	5.3	20.3	96 880	14 080	38 720	1.93	4.0	3.00	1.59	4.59	267 000	6 453	17 681	66
1914	20 000	100	1 350	180	1	10	98.4	45	31	32	17.1	49.9	4.9	19.9	109 920	9 260	38 650	1.92	4.0	3.15	1.71	4.86	273 400	6 470	17 726	65
1915	6 000	100	1 200	70	1	8	98.7	49	33	33	14.7	61.0	9.2	23.5	117 630	7 100	44 460	1.88	4.2	3.07	1.66	4.73	278 727	6 456	17 194	62
1916	9 000	100	1 250	79	1	9	98.7	51	33	35	17.3	59.3	2.3	19.5	129 160	3 320	40 020	20.45	4.3	2.79	2.13	4.92	284 400	6 597	18 025	63

* 24-hour counts on Standard Agar at 37½° C. substituted for Standard Gelatine.

OPERATION OF FILTERS IN 1916.

Number of Filter.	Times Scraped.	Total Hours in Service.	Total Quantity of Water Filtered during the Year, in Gallons.	Average Quantity of Water Filtered between Scrapings.	Average Quantity of Water Filtered per Day.
1	18	8 216.0	687 650 000	38 200 000	2 010 000
2	15	8 187.5	706 180 000	47 080 000	2 070 000
3	19	8 131.5	686 110 000	36 110 000	2 030 000
4	17	8 131.0	634 510 000	40 850 000	2 050 000
5	19	7 969.5	681 990 000	35 890 000	2 050 000
6	18	8 144.0	690 310 000	38 350 000	2 040 000
7	16	8 176.0	693 470 000	43 340 000	2 040 000
8	17	8 098.0	704 690 000	41 450 000	2 080 000
9	17	7 969.5	678 060 000	38 890 000	2 040 000
10	17	7 996.5	680 790 000	40 050 000	2 040 000
Total			6 903 760 000		
Average of Plant	17.3	8 101.9		40 020 000	2 045 000

Lengths of runs in days:
Maximum, 59.3
Minimum, 2.3
Average, 19.5

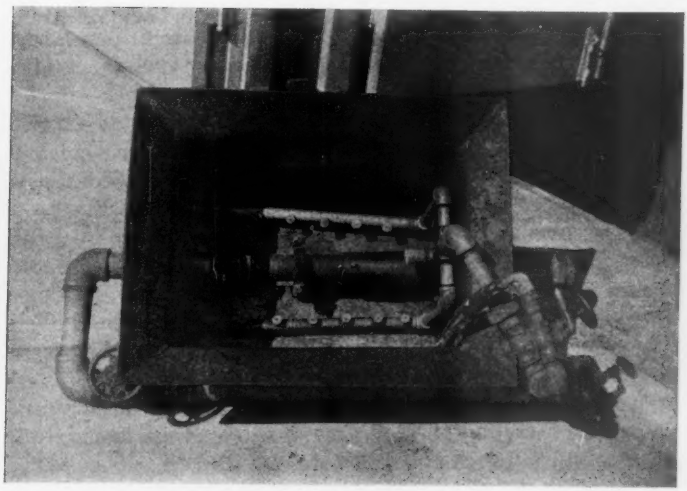

FIG. 13. SAND EJECTOR BOX.

The necessity of frequently changing the two liquefying pipes, caused by the wear about the small holes, made much delay and expense. In an emergency the holes were reamed out to about $\frac{5}{8}$ in. in diameter, and wooden plugs, with $\frac{3}{16}$-in. holes through them, were driven in, forming a nozzle that wore much longer than the iron pipe did. These plugs were made about 1 in. long, $\frac{3}{4}$ in. in diameter at top, and 1 in. at the smaller end. These made a cheap nozzle that could be replaced very easily.

CONSTRUCTION OF THE PHELPS BROOK DAM. WATER SUPPLY FOR HARTFORD, CONN.

BY J. F. SHAUGHNESSY, ASSISTANT ENGINEER, HARTFORD WATER WORKS, HARTFORD, CONN.

[*Read November 14, 1917.*]

The Phelps Brook Dam is situated in the town of Burlington, Conn., in a range of hills west of the village of Collinsville and about one and one-quarter miles to the southwest.

The brook breaks through the hills at a point approximately the middle of an arc of a circle whose center is upstream 1 400 ft.

After providing for the direction of traffic around the dam site, the control of the stream during the construction of the conduit and lower parts of the gate chambers was in order. A wooden flume 400 ft. long, 12 ft. wide, and 4 ft. deep, was built south of the center line of the conduit, and this proved to be of ample size to carry the stream.

When the flume was completed and the water had been turned through it, the excavation for the conduit trench was begun. About two thirds of this was in rock, the foundations for both gate chambers being included in this portion. Blasting was necessary for a distance of about 100 ft. In order to guard against opening up the already seamy rock, light charges of 40 per cent. dynamite were used in shallow holes. Near the bottom of the trench loose pieces were barred out.

All surfaces not showing clean were gone over thoroughly with picks, to remove anything that would prevent actual contact between the ledge and concrete to be poured above it. After a scrubbing with water and wire brooms, a coating of dry cement was spread, about one-quarter bag to the square yard. This was then wetted to the consistency of thick paint and brushed in with wire brooms. On this was placed a coating of thin mortar, consisting of one part cement to three parts sand. The pouring of the concrete was immediately started on this prepared surface.

The conduit is of the horseshoe shape, $6\frac{1}{2}$ ft. high by $6\frac{1}{2}$ ft. wide,

and varying in thickness from 10 in. to 18 in., according to the cover above.

The reinforcing was 1 in. twisted steel bars placed about 12 in. apart and 3 in. from the inner and outer faces running longitudinally. Two other rows attached to these and running at right angles 12 in. apart completed the reinforcing in the arch.

The forms for the invert and outside of conduit were of wood, and built as the work progressed. The inside forms were of metal and furnished by The Blaw Company. The concrete in the conduit is a 1:2:4 mix. A $\frac{3}{4}$-yd. portable Smith mixer was placed near the part of the conduit under construction, being moved from section to section as needed, making a short carry for the barrows.

Both the metal and wooden forms were given a coat of form oil before receiving any concrete, and during the pouring the concrete was spaded to assure smooth surface after completion. Special spades were made for use in the arch, to enable the workmen to reach between the reinforcement rods.

Contraction joints are provided every 25 ft., ingot iron water stops being inserted at each joint.

The ends of sections first built were made smooth except that 4 in. of 8-in. by $\frac{3}{8}$ in. iron were left protruding. Before the adjacent sections were started, these ends were coated with asphaltum paint. The outer ends of each section were treated in like manner, making a practically water-tight joint every 25 ft.

The gate chamber to the elevation of the top of the conduit was built in as part of that structure, other sections 12 ft. high being added as the dam was carried up.

The bolts carrying the ladder and gate stem were inserted through the inner forms, being held in their proper positions with 2-in. by 4-in. blocks. The stop plank grooves starting from the intersection of openings in conduit and gate chamber were held securely by timbering resting on the invert and by wiring to the inside of the gate chamber forms. Succeeding lengths of these castings were held by bolting at the bottom to those already in place and by wiring as in those first mentioned.

While the building of the conduit was under way, excavation of the core wall trench was carried on, the deepest part being about 30 ft. below the level of the brook at a point 150 ft. south of the

conduit. The material in this cut consisted principally of fragments that had been broken from the ledge, with some silt washed in from the valley above. It was removed by operating a derrick with a clam shell and orange peel buckets attached. A similar but smaller depression was encountered 100 ft. north of the conduit and treated in the same way.

After the material above the ledge and along the line of the core wall had been removed and the grouting done in the low section, the building of the core wall began. A section 30 ft. long and 21 ft. wide was cleaned as described, in preparation of foundations in the conduit, the same application of cement and mortar being used.

The core wall was built 8 ft. thick up to the elevation of the brook, about 430 above sea level, and tapered to 2 ft. thick at the water line, elevation 485. From 485 to 490 the uniform thickness is 2 ft.

At the bottom are two aprons, one extending 10 ft. from the upstream and one extending 3 ft. from the downstream face, making in all a 21-ft. contact between the ledge and the concrete. These aprons were built to such a height that at any point the ledge was covered with at least 2 ft. of concrete.

The forms for the sections in contact with the ledge were generally built of wood, as this material could more easily be made to conform to the varying shapes of the rock encountered. Above the first lifts the Blaw forms were used. These forms were made of channels each side consisting of three parts, a center piece 36 in. deep, with a 6-in. piece bolted on either side. Through the center of these 6-in. channels, and at intervals of 5-ft., were passed $\frac{3}{8}$-in. rods. Struts cut to a length equaling the thickness of the core wall kept the forms at the proper distance apart, while a set screw on the rods outside the forms prevented spreading. In each completed lift the upper channel was allowed to remain in place and became the lower channel of the form for the lift above.

At the end of each 30-ft. section, a contraction joint with water stop is provided. The water stops are placed in grooves varying in size from 4 in. by 30 in. to 3 in. by 16 in., according to thickness of wall. In the middle of each groove was inserted 4 in. of the 8-in. water stop. These contraction joints were begun at

the ledge and carried vertically to the top of the wall. The ingot iron is given a 6-in. lap, and is bolted wherever joints are broken.

Three keys were inserted at the top of each layer while the concrete was fresh. Two rows of keys were fastened to the forms leaving grooves 4 in. wide on the bottom, 8 in. wide on top. The center groove was triangular, 8 in. wide on top. All are 6 in. deep.

Each layer of concrete was cleared of laitance loose material and washed before being coated with cement and mortar in preparation for the layer above it.

The material for the construction of the earth embankment came from the basin above the dam. A quarry was opened on the hill to the south, from which rock was delivered to the crushing plant by gravity.

Against the faces of the core wall on both sides was placed loam. On the lower side a uniform width of 15 ft. was carried from the ledge to the water line. On the upper side, the loam is 30 ft. thick, at the brook level being carried from a point 10 ft. outside the apron to this maximum of 30 ft. and brought in at a $2\frac{1}{2}$ on 1 slope, being 8 ft. thick at the water line.

Outside the limits for the loam, gravel was used for the filling except that the upstream face of the dam was covered by riprap from the bottom to an elevation 10 ft. below the water line and from that elevation to 5 ft. above the water line with paving, and the entire face of the downstream side had a covering of loam 1 ft. deep.

In distributing the gravel fill, care was taken to put the coarse, heavy gravel nearest the outside, while the finer gravel was placed nearer the loam.

The gravel was rolled in layers not exceeding 1 ft. in thickness, and the loam in layers not exceeding 8 in., or tamped in those not exceeding 4 in.

At the bottom of the deep cuts, it was impossible to use the heavy rollers required on account of the lack of space in which to operate them, so, instead of rolling, puddling was substituted. For a space of 10 ft. outside the apron the loose material was removed from the ledge, then the hole was filled with enough water so that the loam when dropped in was wholly covered. This portion of the loam was dumped from the trains at a place convenient to

the derrick that had done the excavating and by it deposited where required.

Loam and gravel were brought to the embankment in 4-yd. dump cars, 18-ton locomotives were used, carrying trains of from 3 to 6 cars as the elevation of the dam increased.

At Phelps Brook Dam there was little trouble from the water encountered below the level of the brook, one pulsometer pump of 4-in. discharge being sufficient to care for it at any time.

DISCUSSION.

PRESIDENT SAVILLE. There are one or two things in the paper I should like to speak of particularly. Mr. Shaughnessy speaks of the Blaw forms being used. They were about 4 ft. wide and 30 ft. long, perhaps. They were moved by the traveling derrick that handled the concrete buckets. At first they did very good work; the surface of the concrete came out nice and smooth, and we were very much pleased with them. But, after being used for some little time and moved around with the derrick, they became shaky, would sway when moved. They did not give good satisfaction towards the end, and at the very last, wooden forms were used which were very much more efficient. The fault, if you can speak of it as a fault, was in not having stiffners enough in the forms themselves to keep them rigid. The Blaw people might say the fault was in the method of using them; that, if we had treated them with more respect, they would have done better; that they were not intended to be knocked around as was done. Be that as it may, on construction work you have to move things as best you can.

Another point which may be mentioned was the method of placing the concrete. The rock, as intimated in Mr. Shaughnessy's paper, was brought down by gravity to a crusher, crushed, raised by a derrick and orange-peel or clam-shell buckets to a considerable height, and then dropped into the hopper of the concrete plant which was at one end of the work. This hopper had two compartments in it, one for stone and one for sand, from which these materials flowed by gravity to a mixing platform and into measuring hoppers at that point. After this was discharged

into the mixer, the cement was added and the materials thoroughly mixed. It was then raised about 10 ft. on an elevator and dumped into a chute and delivered at the elevation where we were working on the dam. It was then dumped into small cars and run along the side of the core wall, the locomotive taking a flat car with two of those buckets. At the point where the concrete was put into the dam, there was a very awkward derrick, which moved the forms and took this concrete up and dumped it into the forms. We found as the work progressed that that was a very unfortunate place to have the derrick because it interfered with work on the embankment. The upstream portion of our soil core, which was one of the defenses against percolation, was on that side. This track and derrick and the maneuvering of it was a very great nuisance, so that we were not able to do the work as efficiently as we would have liked to do on the upstream side. A suggestion which came from this work was that the next time any work of this kind was done all the machinery should be placed on the downstream side, leaving the upstream side clear.

The foundation rock was a schist, soft in places, and it was interesting to find seams that had formerly been filled with pegmatite, which had become softened to a clay-like material by the water which had percolated down from above. Some of it was almost the consistency of putty, and in other places the material had become like chalk. It could be picked out with the fingers or carved with a knife, and if it got wet it became putty-like again, smooth and slick. That stuff was all taken out. Then grouting was started. The grout holes were arranged in three rows about 7 ft. apart and 25 ft. deep. In the first place those holes were filled with water through a meter to show how much water was lost. If a large amount of water was needed it was taken as evidence of a big seam. A special form of pipe was then put in, with a rubber dam, which by screwing together expanded a rubber washer that closed the hole tightly at the top. Water pressure was then put on the hole, something more than 10 or 15 lb. perhaps; anyway, more than any pressure which would come on that point from the water in the reservoir. That proved to be a most efficient way of finding any holes, seams in the rock, or slabs. The rock lay in some places almost vertically, and it

was almost impossible to find any seams in it; but by putting water pressure on, seams would be uncovered by the blowing off of large slabs. Sometimes some of the concrete would be blown off. We found it a most efficient way of searching out seamy rock, by putting water pressure on it.

The material of the dam was loam; that is, from about 30 ft. out on the upstream side was this layer of loam, using black loam from the valley above and about 8 in. of yellow loam underneath, great care being taken not to get too deep into the yellow loam so as to meet the sandy material. Outside of that was placed clean gravel, the finer materials, so far as we could, being placed toward the inside and the coarser toward the outside; and outside of that a paving of heavy blocks of stone; and we chinked that with smaller stone, making a very efficient armor, as it has proved, against the action of the waves.

MR. FRANK A. FULLER. What kind of cement did you use?

PRESIDENT SAVILLE. Lehigh and Knickerbocker both were used.

MAINS.

TOPICAL DISCUSSION.

MR. GEORGE C. BERTRAM. I represent the Lock Joint Pipe Company, and I should be very glad to give you any information I can on the subject of reinforced concrete pipe.

For a number of years, we have been experimenting with reinforced concrete pipe for pressure purposes, not so much for street work, but for large supply mains. We have carried on a number of experiments and tests on pipes varying in size from 24 in. in diameter to 108 in., and have drawn the conclusion that it would not be economical to build pipes for a pressure higher than 125 ft.

We recommend and use a very low safety factor in our steel, namely 10 000 lb. per sq. in. This we found necessary on account of the stretch or elongation which develops in steel when put under pressure. Although we have tested 48-in. pipe up to 96 lb. per sq. in., we do not consider this economical owing to the excessive amount of steel reinforcement required.

In our experiments as well as in our construction work, we found that it was absolutely necessary to provide for contraction and expansion at every joint. We have developed an expansion and contraction joint that has proved very satisfactory.

We have built a number of large lines, both in diameter and length. The first large construction was the 108-in. inside diameter pipe for the city of Baltimore. This is about one mile long, and is operating under a 75-ft. head. We have since built a number of other lines, one at Dallas, Tex., a sewer force main, approximately 14 400 ft., operating under an average head of about 50 ft. This line was a 36-in. inside diameter, and the pipe was manufactured in 8-ft. lengths, a copper expansion joint being used in every joint. When this line was tested, clear city water being used, it showed a leakage of about 17 000 gals. in its entire length in twenty-four hours.

We also built a line for Fort Worth, about 14 500 ft., of which 1 528 ft. was 36-in. pipe, the balance being 48 in. inside diameter.

This line operates under an average head of about 45 ft. This line, when tested, showed a leakage of less than 15 000 gal. in twenty-four hours of its entire length.

We now have under construction about ten miles of 66-in. diameter pipe for the Greater Winnipeg Water District. We have built a twenty-seven and one-half mile line of 42-in. pipe on the Pacific coast at Victoria. We have built a number of smaller pressure lines for both water and sewer purposes. At the present time there is being built in Philadelphia, to be operated under about a 15-ft. head, a large sewer siphon about 6 000 ft. long.

I wish to call your attention to the fact that we recommend the use of contraction or expansion joints in every joint, and this recommendation is based on the examination made of lines that have been in operation for some time. I have personally examined a line where for a distance of 120 ft. there has been no sign of contraction and then every joint would open, for a number of joints, there being no regularity as to where the contraction takes place; so in all our construction work we use an expansion or contraction joint at each and every joint.

We feel that this is a particularly good time to call the attention of the Association to reinforced concrete pipe lines, as same can be constructed at a very much lower cost than either cast iron or steel. As an example, we are now constructing an outfall sewer line in Lake Erie for the city of Cleveland, 84 in. in diameter. This was taken in competition with steel pipe $\frac{1}{2}$ in. thick. The total price for the steel pipe bid on this work was $670 000 in place, and, for the reinforced concrete pipe in place, $360 000. This is but an example of what can be done, and I simply cite this example of a recent piece of construction work. We are making this pipe for the city of Cleveland in 20-ft. lengths, and each piece weighs about 25 tons. The pipe is known as a ball-and-socket type of pipe, flush both inside and outside. We recommend and use pipe in 8-ft. lengths for pressure pipes, whereas our sewer pipe and pipes not used for pressure purposes, we manufacture in 4-ft. lengths. In each and every pressure pipe we provide, at the time we construct the same, a copper ring which has a V-shaped bead formed in it. This is molded in the spigot end of the

pipe at the time it is manufactured. This copper joint extends into the joint and overlaps the reinforcement from the bell of the adjoining pipe. We recommend and use a mixture of 1: $1\frac{1}{2}$: $2\frac{1}{2}$ concrete, and do not recommend the use of waterproofing compounds. In fact, have not and do not use the same ourselves.

MR. S. H. MCKENZIE. I should like to inquire why you do not use waterproofing.

MR. BERTRAM. In answer to Mr. McKenzie's inquiry in regard to waterproofing, we have not found any waterproofing as yet that we would recommend using. A Portland cement concern makes what they call a waterproofing cement, and their representative came to me in Cleveland and wanted us to use their waterproofing cement, and use a leaner mix, stating we could save money by doing this. Upon investigation, I found that we should not get as good results, and the final cost, owing to the increased price of this so-called waterproofing cement, would make the concrete cost more money than in the mix we were using there, namely a 1: $1\frac{1}{2}$: $2\frac{1}{2}$ concrete.

We have found that a small percentage of clay apparently does not harm the concrete and does waterproof the steel better than any of the so-called waterproofing compounds offered on the market. I would call your attention to the experiment and test made by the Aberthaw Construction Company, of piles in salt water that were suspended from the Charlestown Navy Yard dock.

MR. JAMES E. BLINN.* I can bear out the statement which Mr. Bertram has just made about making concrete waterproofing. For twelve years now in the Board of Water Supply Laboratory we have tested most of the medicines which have been suggested for making concrete waterproof, and our engineer inspector has repeatedly told me that he has not yet found one which was any good, and some of them are positively injurious. The best way to make waterproof concrete is to properly proportion it and mix it long enough. People are only beginning to realize, I think, the importance of sufficient mixing. This idea that you can turn a concrete mixer over a few times and turn the half-combined ingredients out and call it concrete has got to be given up, or there will be more trouble with concrete when used under trying condi-

* Of New York.

tions. Thorough mixing not only makes your concrete more watertight; it makes it work better in the forms, and in every way more satisfactory.

MR. MCKENZIE. Wet or dry?

MR. BLINN. Wet, by all means. The dry process is really the cause of more trouble in concrete pipes than anything else which has ever been used. Not too wet. You have got to use a happy medium. In Winnipeg there is approximately 12 to 20 per cent. of very fine sand, all good and clean, that gave us very satisfactory results with even a less amount of cement than the coarser sand which requires a lot of cement to fill it up.

MR. HENRY R. BUCK.* What precautions do you take to insure that the joint at the top is as dense as at the bottom? I should think you would get lots of trouble at the top, that it would settle at the bottom.

MR. BERTRAM. We always start with a grout mixture.

MR. F. N. SPELLER.† I have prepared a few notes by way of summarizing the status of welded pipe made with the bell and spigot. This is not at all full, it is just to round out the subject and start something. I might state that we have withdrawn all this from the market at the present time, so that there is no object here of accelerating the use of this material. This was done for the sake of conserving steel in the present emergency, for we feel that where emergency water works must be built at this time there are other materials which can be used in most cases, while steel is more necessary, of course, for other work.

Just one point I would like to emphasize in connection with this class of pipe, and that is the matter of reliability. I had the pleasure recently of visiting a number of installations in the Middle West and in California, and the one feature in all the service that struck me most was the fact of the few number of actual failures. What I mean by "failure," as I have said here, is a total collapse of the system, a burst or broken pipe that would completely shut off the supply for any length of time. I should like to mention three localities. For instance, Butte, Mont. The whole record of that system for the last thirty-one years, I

* Consulting Engineer, Hartford, Conn.

† Metallurgical Engineer, Pittsburg, Pa.

think, in which they have been using this class of pipe exclusively, shows that they have had six failures of that class. In Ogden, in twenty-seven years, thay have had one failure; and in Colorado Springs in twenty-five years they have had no trouble of that kind at all.

MR. CARSTEIN.* In this afternoon's meeting there was an interesting discussion on the waste of water, which should be of interest in connection with the talk on pipe, — especially the service pipes as they are mentioned by the President. I think that the time has come when we should pay more attention to service pipe lines, — that is, from the main in the street to the building. Much of the water which is wasted, undoubtedly wastes through rust holes in the steel and wrought-iron pipe which is used for that purpose now. I need not emphasize, I believe, that cast iron has proved its ability to last, — not only last but to carry service uninterruptedly. Where other pipe can cite a twenty-five or thirty year service, cast iron can cite a 250-year continuous service. Now, in the placing of cast iron between the street main and the building, it is quite possible to install it at a reasonable figure, — one that would compare favorably with 1-in. lead pipe. But we are enabled to use a 2-in. pipe instead of a 1-in. pipe when using the cast iron, and thereby get a better capacity, a pipe which will not fill up so readily, one which can be cleaned when it may be filled up with mud or other sediment, and one which will last as long as the mains.

MR. A. B. MCMILLEN† (*by letter*). The National Tube Company has asked me to write you relative to the experience of the Water Supply Company in the use of pipe. I will say that the present water system was installed about the year 1886, and has been gradually added to since that time, and there are now something over thirty miles of mains in use. Formerly, we used galvanized and dipped lap-weld steel pipe with lead joints, but later changed to National coating. Our system is composed wholly of these two classes of pipe.

The lower portion of the city has alkali soil, which is very hard on ordinary pipe, but the coating seems to protect the pipe from the effects of alkali.

* Of New York.

† President, Water Supply Company, Albuquerque, N. Mex.

Most of the pipe put in thirty years ago is still in good condition, and the results of the pipe used have been highly satisfactory. On account of light weight and long lengths, it is much more economical to lay and handle than cast-iron pipe. As we have not used cast-iron pipe, I have no means of comparing them with respect to length of service.

We have been convinced, however, that the use of the lap-weld pipe with National coating was superior to anything else for our purposes, as you may judge from the fact that we have used no other kind.

Mr. B. B. McReynolds* (*by letter*). We first installed 13 000 ft. of 14-in. Matheson Joint pipe in 1892. This was installed as a mountain flow line at an elevation of from nine to six thousand six hundred feet, the soil conditions being granite rocks and disintegrated granite. The present condition of this pipe is excellent. It shows very little deterioration from rust either inside or out. We have had several rock slides along this line, but have never had a broken pipe. We have had them dented and the joints pulled apart, but have always been able to get the pipe together without patching or installing additional pipe. This is where steel pipe has an advantage over cast iron that works out in practice; that is, the ease in making repairs in remote places and places hard to get to. Mind you, I do not want to claim that steel pipe has the life of cast iron, or that it will take the place of it (we use cast iron for tapped mains exclusively and also for adobe and alkali soil), but from the present condition of this pipe line it will last twenty-five years more and possibly longer.

Since the installation of the above pipe line we have used steel pipe for the following lines:

1904	7 000 ft. 20-in.
1904	22 000 ft. 16-in.
1911	17 000 ft. 16-in.
1906	1 500 ft. 20-in.
1906	15 000 ft. 24-in.
1911	11 000 ft. 12-in.

This is all in good condition, and is giving excellent service.

* Superintendent, Water Department, City of Colorado Springs.

We have purchased recently and are now installing the following:

9 500 ft. 20-in. National coated pipe.
15 700 ft. 18-in. National coated pipe.
8 700 ft. 16-in. National coated pipe.

I mention this only to show that we consider steel pipe satisfactory after a number of years' trial and service.

Would sum up like this: We have had steel pipe in service from six to twenty-five years, and it has given us no trouble to date. We would recommend this pipe for flow lines where soil conditions are right, above all other kinds. We use it because we consider it better pipe for mountain flow lines and where soil conditions are right, on account of its ease to install and handle and because there is no danger of falling rocks and slides breaking it; also it has a life of more than fifty years.

This is all borne out by our experience with this 13 000 ft. of National Tube Company Matheson Joint pipe, which we have had in service for twenty-five years.

MR. EUGENE CARROLL* (*by letter*). As the Butte Water Company has used steel water mains exclusively for the past twenty-six years, I am pleased to give you a few facts concerning our system, particularly as it relates to the distributing system of Butte.

The corporate limits of Butte are very small, but the surrounding country is thickly settled, so that it is impossible to note where the city ends and the country begins. A conservative estimate of the population served by the Butte Water Company would be one hundred thousand people. In addition to the domestic consumers, we cover the district occupied by the large copper and zinc mining companies in this vicinity, which take enormous quantities of water in their operations. On June 30 of this year, which is the date of our last report to the Public Service Commission, we had a total number of eleven thousand and forty-four consumers of all classes, seven hundred and twenty-seven of which are metered, including all of the mining companies, industrial plants, and large consumers. It is not the custom of the company to meter residences, except apartment houses, hotels, and boarding-houses. The average daily consumption of water during the fiscal

* Manager, Butte Water Company, Butte, Mont.

year ending June 30, 1917, was twelve million six hundred and thirty-six thousand (12 636 000) gallons.

As the mining companies and mills vary materially in the amount of water consumed from month to month, and because the water company is liable to be called upon at any time to supply enormous quantities of water to fight underground fires, our pipe system and water supply is more extensive and of larger size than would seem warranted by the number of consumers and house connections.

The water supply is obtained from three different sources. The Basin Creek supply is obtained from a storage reservoir on Basin Creek thirteen miles south of the city, and delivered to the distribution system by two 24-in. influent pipe lines. The Moulton system is supplied from an impounding reservoir seven miles north of the city and conveyed to the distribution system by a 12-in. influent pipe line (which is now being replaced with a 16-in. influent pipe line). The Big Hole system takes its water from the Big Hole River about thirty-two miles south and west of the city, pumping the same across the Continental Divide to a distributing reservoir, a distance of about nine miles from the pumping station, thence by gravity through a 24-in. influent pipe line to the distribution system. The total capacity of the influent supply lines at the present writing is eighteen million five hundred thousand (18 500 000) gallons in twenty-four hours, and the company is about to install an additional pump and pipe line from their Big Hole Station to Butte, which will increase the daily capacity eight million (8 000 000) gallons.

In 1891, the Butte Water Company purchased the small waterworks plant then supplying the city of Butte, and began the enlargement and rebuilding of the whole plant, developing the Basin Creek supply first. The distribution system of the old water plant consisted of ordinary screw-joint pipe from 2 to 6 inches diameter, with the exception of about two miles of 8- and 10-in. National Tube Company's Converse Joint Kalamein pipe, which was laid in 1886, and about four miles of 3- and 5-in. Kalamein pipe with Converse Joint, furnished by the National Tube Company.

Since that time National Tube Company steel pipe has been

used exclusively in the distribution system. Originally, Kalamein pipe with converse joint was used, but since 1912 the Matheson Joint pipe, manufactured by the National Tube Company, has been used exclusively. Upon the adoption of the Matheson Joint instead of the Converse Joint, the Kalamein was abandoned and the National Coating substituted. The Kalamein pipe which was in the old system when the present company acquired it in 1891, with the exception of two miles of 5-in., which was removed to increase the size of the pipe, and which was used in other parts of the system, is still in the ground and giving us no trouble. From the records of the old company, the first Kalamein pipe was laid in 1886. This pipe is at present in service on Main Street of Butte. When Main Street was paved, about ten years ago, this pipe was exposed for its whole length for examination and found to be in such excellent condition that it was not considered necessary to replace it for the permanent paving, and it has given no trouble whatever up to the present writing.

The first 24-in. line from Basin Creek, built in 1892, is constructed of banded Redwood Continuous Stave pipe to within a mile and a half of the city limits, from which point a 20-in. Kalamein pipe with Converse Joint was laid for a distance of three miles to the center of town. This pipe is still in operation, and recent investigations show it to be in excellent condition practically all of the way. This Kalamein pipe has given us no trouble at all, and while it is pitted a little where it crosses a swamp, either from electrolysis or acids in the ground, it is in first-class condition to-day.

The Big Hole pipe line was built in 1898–9 and consists of 24- and 26-in. Continuous Stave Redwood pipe with riveted steel pipe where the pressure exceeds two hundred and fifty feet. This line is still in excellent condition, no trouble having been experienced with either the wood or the steel to the present writing. In 1912 an additional 20-in. Kalamein steel pipe was laid from the end of the wooden pipe on Basin Creek line No. 1, a distance of over three miles, connecting to the eastern part of our distribution system to reinforce the water supply. In 1914 an additional pipe line was constructed to Basin Creek reservoir parallel to line No. 1, connecting to the distribution system at the city limits.

This pipe is constructed of 7.26 miles of 24-in. Continuous Stave Oregon Fir pipe and 2.5 miles of 24-in. National Coating Matheson Joint pipe manufactured by the National Tube Company. The contract has been let to the National Tube Company for 18 000 ft. of 16-in. Matheson Joint pipe National Coating to replace the present 12-in. wooden pipe line from the Moulton Reservoir to the city. This is a very old pipe, requiring renewal and increase in capacity owing to developments of that water supply in the past five years.

Summarizing, — the water system of the Butte Water Company has 525 000 ft. of National Tube Company's steel pipe in their distribution system of both Converse and Matheson Joint, with 300 000 ft. of influent pipe lines which consist of 226 954 ft. of Continuous Stave and machine-banded wooden pipe, 38 604 ft. of Riveted Steel pipe, 17 042 ft. of 20-in. Matheson Joint pipe, 3 000 ft. of 20-in. Converse Joint pipe, 13 200 ft. of 24-in. Matheson Joint pipe, National coating, and 1 200 ft. of 26-in. Matheson Joint pipe with National coating.

We have under contract, and about to be constructed, 18 000 ft. of 16-in. Matheson Joint pipe, National coating.

The advantage of steel pipe in the water system of Butte may be summarized as follows: The first cost is much less than cast iron. The cost of laying is considerably less than the cost of laying cast iron. The cost of maintenance and repairs is considerably less for steel than cast iron. The life of steel pipe properly coated is yet undetermined, but the fact that the city of Butte has steel pipe which has been in the ground for thirty-one years and is still in excellent condition would warrant the statement for this community, where the freight rates are high and cost of labor the highest in the country, that it is more economical to use steel pipe than cast iron.

During the past twenty-six years in handling steel pipe for the water works of Butte, we have had only six burst pipes attributable to defective pipe. In laying the Matheson Joint pipe on our 24- and 26-in. influent pipe lines we have the remarkable record of not having a defective joint, although the pressure is as high as 150 lb. per sq. in. in most of the joints.

In designing the plant for Butte and other communities in

Montana, where the writer has been employed as consulting engineer, the consideration which has always governed is a financial one. The life of steel pipe properly coated, as far as the writer knows, is yet undetermined, but for purposes of comparison he has found that, even admitting that the life of cast-iron pipe is twice as long as steel pipe, in a growing community he generally figures that the increased cost of installation of cast-iron over steel, and the increased cost of maintenance and operation of the cast-iron system over a system composed of steel, warrants the substitution of steel for cast-iron pipe. In influent pipe lines the increased capacity of steel pipe over cast-iron is quite a material matter, and where the delivery of pipe over mountainous roads is quite a figure in the cost of construction, the advantage of steel pipe over cast iron is even greater. In a growing community where frequent changes are necessary to increase the capacity, the lesser first cost is quite a factor for the engineer to consider. Particularly in small communities, where the amount of money to be expended is limited and where the desire of the community is to cover the largest amount of territory with the least expenditure of funds, there is no question that the use of steel pipe is advisable.

Owing to unusual conditions, there is a great deal of electrolysis to be contended with in the Butte district. The water company has been endeavoring to have this remedied for many years, and has succeeded in forcing the street railway company to place return feeders to their power stations and make other improvements, tending to reduce the large electrolytic action from that source. Beside the street railway company there are two railroads passing through Butte operated by electricity, as well as many surface and underground electric tramways around the mines. It is questionable, in the writer's mind, if cast iron would not be subject to as great damage as the steel pipe, though we have had no way in which to compare the relative resisting qualities of the two pipes to electrolytic action.

While not committing myself in future work, believing that every separate plant should have intelligent study, and believing that the selection of the proper materials to be used in the construction of a water plant depends largely on local conditions, the

writer is free to say, from his twenty-six years' experience with steel pipe, that it has been very satisfactory in Butte and other communities in Montana with which he is familiar. He does not hesitate to recommend it for water works, and in designing a new system would take into consideration more particularly the first cost of installation, cost of maintenance, repairs and operation in deciding between the use of steel or cast iron.

MATHESON JOINT STEEL WATER MAINS.

BY F. N. SPELLER.*

[*Read September, 1917.*]

For about thirty years welded steel bell and spigot pipe has been used for water mains. For the past ten years most of this has been made with the expanded end known as the Matheson Joint. Failures of the kind reported every week or so in the newspapers with cast iron have so far been practically unheard of with this kind of pipe. This unbroken record of reliability is not affected by occasional leaks due to severe corrosion or electrolysis or collar leaks which occur also in cast iron or other pipe. Reliability in service is based on the large and uniform factor of safety, especially against shock which obtains in this class of steel pipe. There are none of the hidden blowholes and other defects to be expected in cast metal. The foundation does not have to be so rigid. More power can be safely employed in calking and a much wider range of pressure can be safely carried in the same pipe compared with cast iron. Instances have been reported where this pipe has been permanently dinted and distorted by rock slides without leaking or interrupting service. For these reasons, and considering the large saving in weight, it is not surprising that Matheson Joint steel pipe has become so generally used in the mountain districts.

Each length of this pipe has a suddenly applied test pressure of 450 to 600 lb. at the mill. This, together with the strain which is put on the weld and material when the bell is rolled out, makes it almost a certainty that there will be no failures in service.

Carrying Capacity. Several tests have been run in service where cast iron and welded steel lines were conveniently located for this purpose, which proved the larger carrying capacity of the latter.† This has been carefully determined on new pipe (4-, 6-, and 8-in.) in some elaborate tests under the supervision of the Underwriters' Laboratory, the results of which will be pub-

* Metallurgical Engineer, Pittsburg, Pa.

† *Engineering News*, November 9, 1916. Report on Glenwood Springs System, Colorado.

lished in the near future. These tests indicate an increase in capacity of 20 per cent. in the steel over cast iron of the *same*

FIG. 1. AN EXAMPLE OF THE VALUE OF "NATIONAL" MATHESON JOINT PIPE LAID IN A COUNTRY WHERE ROAD CONSTRUCTION WAS IMPOSSIBLE, AND THE PIPE WAS CARRIED BY AERIAL CABLE TO OTHERWISE INACCESSIBLE POINTS.

inside diameter. As Matheson Joint steel pipe is made to O. D. and cast iron to I. D., the difference in favor of the steel on these nominal sizes is found to be 3 to 4 per cent.

Durability. The service records covering the past thirty years

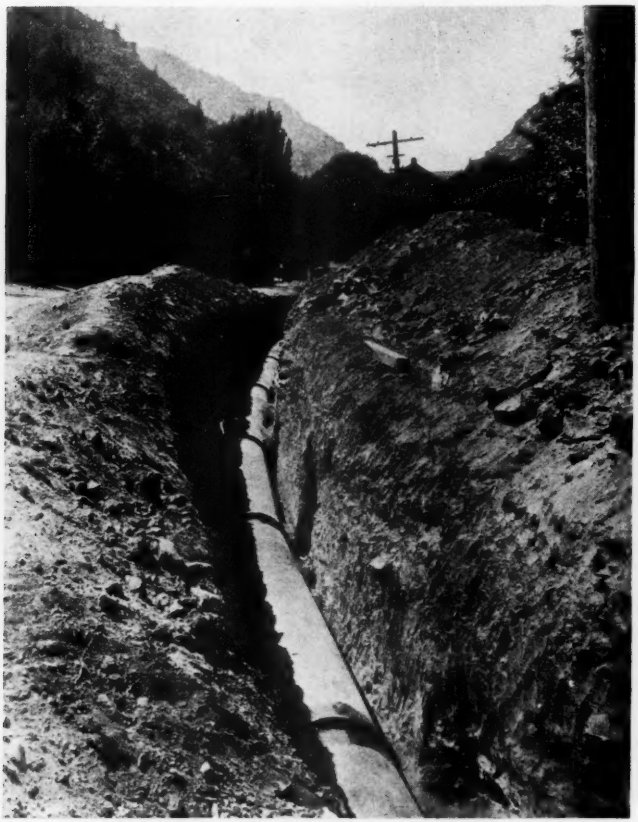

FIG. 2. SECTION OF A LINE OF 17 250 FEET OF 24-INCH O. D. "NATIONAL" MATHESON JOINT PIPE INSTALLED BY A CITY IN NORTHERN UTAH (OGDEN) THREE DEGREES PER LENGTH.

also indicates less tuberculation on steel, although this trouble, like corrosion, varies so much with water conditions that it is difficult to make close comparisons. Durability is usually dis-

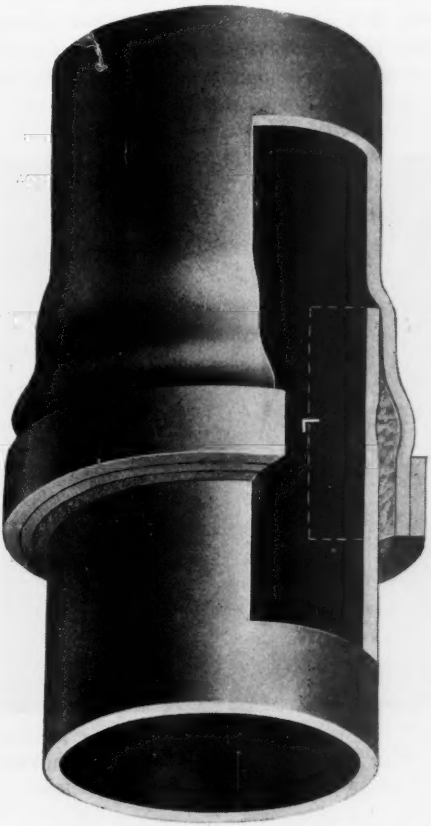

FIG. 3. "NATIONAL" MATHESON JOINT — SECTIONAL VIEW.

cussed in conjunction with strength and reliability in service when, as a matter of fact, they are separate problems which involve materials having widely different properties. Cast iron is

necessarily made comparatively thick on account of the weakness of the metal and limitations of casting operations.

To take advantage of the lighter weight and greater strength of steel, and at the same time increase the durability in service, involves the use of a reliable protective coating. Much has been done along this line of late years, led by the demands of the oil and gas interests, where high pressure and consideration for safety have made welded steel pipe the standard.

FIG. 4. CURVATURE ABOUT 50 DEGREES PER 100 FEET. DEFLECTION IS MADE BY FIVE-FOOT LENGTHS.

Where conditions are very bad, as in tidewater swamps, permanent protection has been obtained by boxing the pipe and filling in with two inches of well-mixed concrete. While this has been proved satisfactory by twenty years' experience, a cheaper and more flexible coating is usually all that is required.

Before any coating is decided upon, however, a careful survey of local conditions should be made to determine how much bad strata the pipe will pass through. It usually turns out that only five or ten per cent. of the system is exposed to conditions which might cause apprehension, and such localities may be carefully protected without involving a considerable expense per foot over the whole line. However, it is safe to say that some protection should always be provided underground. This may be only a dip outside and inside in hot asphaltum of good quality. This acts as a good priming coat should it be thought advisable to add further protection. We advocate a wrapping of fabric saturated with a good quality asphalt pitch having a flow point of about 150 degrees F. Another layer may be applied if necessary.

Special machinery has been designed to apply this coating tightly and uniformly at the place of manufacture, but if conditions warrant, the coating may be applied in the field after cleaning and drying the line and applying a thin priming coat such as coal tar dissolved in benzol. The Standard Oil Company of California applies two layers of asphalt of high melting point to the cold pipe as soon as the priming coat is dry, which is covered spirally with a strip of burlap about eight inches wide. Another thin coating should be applied to saturate and preserve the burlap. The writer has seen lines where the coatings so applied were $\frac{1}{4}$-in. thick on top and $\frac{5}{16}$-in. underneath. These oil lines operate at 700 to 800 lb. pressure. This would seem to be approaching the ideal system, where the pipe is strong and ductile enough to stand any reasonable amount of settlement or shock and where the coating is made of the material which experience has taught to be the best to withstand soil corrosion and electrolysis.

Inside corrosion of water mains has given comparatively little trouble; a properly applied dip has given all the protection required in the large majority of cases.

A SMALL WATER WORKS TESTING LABORATORY.

BY A. N. FRENCH, SUPERINTENDENT OF WATER WORKS, SENECA FALLS, N. Y.

[*Read November 14, 1917.*]

Within the last year or two water-works men have often had their attention called to the fact that there are many small filtering plants which do not have chemical laboratories, which do not make tests of the quality of the water, and which are in general operated without proper supervision. One of the latest papers of that sort which I have noticed is from the pen of Mr. Ray C. Werner, chemist of the Georgia State Board of Health. He urges that every water works which has a filtering plant should have a suitable laboratory for the purpose of making tests of the water and counting the bacteria.

I imagine that most water-works men realize the desirability of a laboratory, but they regard such a thing as beyond their financial means; as requiring much special education; and as, in general, something unattainable. In order to illustrate that it is not so very difficult or costly for a small water works to set up a laboratory, and that it is within the ability of almost every superintendent or chief engineer of a pumping station to gain the necessary knowledge in order to operate it, perhaps the experience of my company, and that of the chief engineer and myself, may be of interest.

The water supply for Seneca Falls, N. Y., comes from Cayuga Lake, one of the " Finger Lakes " of Central New York. Cayuga Lake is forty miles long; its depth reaches 410 ft., and its width varies from one mile to five miles. Its drainage area is mostly a farming country. The land is nearly all under cultivation, there being almost no forest land or waste land. The largest place on the lake is Ithaca, forty miles from Seneca Falls, and with a population of about 16,000. There are several small villages of a thousand or two or less, and the rest is farming country.

The waters of these Finger Lakes, like those of the Great Lakes, are naturally pure and fine, and in some instances are still so. The city of Rochester takes its domestic supply from Hemlock Lake without filtration or chlorination. The village of Penn Yan, which has some five thousand population, takes its supply from Keuka Lake without any sort of treatment. The city of Syracuse treats the water of Skaneateles Lake with chlorine. The city of Geneva has filters; and the city of Auburn is constructing a plant.

The state analyses of the water of Cayuga Lake at times indicate the presence of B. coli, and in times of freshet there is considerable turbidity. Our company installed rapid sand filters which were put into operation in the spring of 1913. The chief engineer and myself very soon felt that we were working in the dark, and set about accumulating knowledge necessary for the establishment and management of a small testing laboratory. We visited the cities near us which had filtering plants, and we bought books, and read and studied. We got more help from a book put out by the American Public Health Association, "Standard Methods of Water Analysis," than from any other book we had access to.

We were fortunate, at this stage, to bethink ourselves of the State Experiment Station at Geneva. We went there and made the acquaintance of Dr. Breed, bacteriologist, who gave us a great deal of help in the way of information and advice. Later he sent us a young man who was associated with him, and who had some experience in water analysis, and who made up for us a list of apparatus and chemicals necessary. After we got our apparatus and supplies, he came and stayed a few days with the chief engineer, and saw him started in the right way.

We partitioned off a small room in one corner of the upper floor of our filter building, built a bench, and made provision for the storage of our chemicals and apparatus — a matter of some cupboards and shelving.

We bought chemicals, glass ware, scales, magnifying glass, etc., of the Bausch & Lomb Company at Rochester. The larger pieces of apparatus are the most costly, and the purchase of them is the heavy financial item in setting up a laboratory; but, thanks

to suggestions of Dr. Breed, we got over that part quite cheaply. For instance, instead of purchasing an expensive incubator we bought the smallest size of chicken incubator, costing us about seven dollars. For a hot-air sterilizer we bought a kerosene-oil stove and oven. We made our own autoclave from a piece of 8-in. steam pipe, and heated it with steam from our boilers. So that those expensive items of apparatus, which would have cost a good deal if bought of a maker of bacteriological apparatus, with us represented very little money.

With a moderate amount of traveling about, a small expenditure of money, — totaling, as I recall, around one hundred dollars, — and with a good deal of reading and study, we are now equipped and able to make the presumptive test for B. coli, the bacterial count, the test for alkalinity, and the test for free alum.

We have been making tests regularly for over two years now, and keeping a record of the results; and it is a lot of satisfaction to be able to do so. Of course our main reliance is on the fermentation test for gas-forming bacteria and the bacterial count. We make those two tests once a month. Our lake is so large, and its water is so constant in quality, that we do not feel it necessary to make more frequent tests. We have never had any gas formers in our filtered water, and often there are none in the raw lake water. The bacterial count in the raw water is not high either, except in time of freshets. Often it will be as low as 25 per c.c., but in time of flood it will run up to several hundred. In the filtered water our counts run as low as 5 per c.c. and as high as 40. We make our bacterial counts on agar, using the regular petri dishes.

The alkalinity test is not made very often. The lake water is about 80 or above, as a general thing, and, as we use only one-half grain or less of sulphate of alumina per gallon, we have such a margin of safety in alkalinity that we are safe, except in time of flood, when it will go down to zero, or nearly so, for a few days. Then is when we want to test for alkalinity, and if we could not do it, we would be unable to understand why our filters "did not work right," or know what to do.

Another satisfaction which we have had from our laboratory has been our ability to make tests on the wells about the village. This country is a clay-soil country, and in time of floods much

turbidity gets into our lake. Consequently all of the older houses had their own wells. People did not like to drink roily water, and from a well they can almost always get clear water. Also there is much vegetation growing in our end of Cayuga Lake, and the lake water always tastes and smells of it. We have found, by testing wells scattered over the village, that most of them contained gas-forming bacteria, and the total count was high. By carefully disseminating that information we have cut down the use of well water largely. Every year sees a fewer number of wells in use. The filtering of our water keeps the sediment out of it, the bacterial count low, and removes most of the vegetable smell and taste, so that our people are losing their prejudice against it.

We would not be without our little laboratory for many times what it cost, and our experience leads me to think that almost any superintendent of water works or chief engineer of pumping station can have such a laboratory if he wishes, and make regular tests of the water. The cost is not prohibitive, and the necessary knowledge can be obtained.

DISCUSSION.

MR. ROBERT SPURR WESTON. I think this paper is along a very good line, and one that is well worthy of attention. Many plants which are designed by the best engineers have not worked properly because, after the end of the contract period, the engineer has had no further control of the plant, and the water has been over-treated or under-treated, the filter bed has not been taken care of, or some other accident has happened, which has given the plant a bad name. As a result the engineer very often gets blamed for what is not his fault. Therefore this paper ought to be emphasized as a step along the right path.

Water purification plants may perhaps be grouped in three or four classes. The first class includes those where the water works employs a chemist all the time. This does not cost less than $2 000 a year for a first-class man, with equipment, supplies and everything, and that expenditure, of course, is possible only in the larger works. I think about $3.00 per 1 000 000 gal. is about

the limit that any works can pay for this sort of supervision. That would mean $329 a year for a small works, producing 300 000 gal. a day.

The second class is where the local engineer or superintendent himself makes the tests for turbidity, alkalinity, and so forth, and then some central laboratory, state or private, makes monthly or bi-monthly or quarterly analyses. This is a very efficient way of controlling plants, especially small ones.

Then, again, there is the third grade of supervision, where there is no works laboratory, but where a central laboratory makes an inspection every month. That is the kind of supervision which all of our Massachusetts plants get, and this is the minimum which any purification plant ought to get.

Then the fourth grade, of course, is where there is no laboratory supervision at all.

One difficulty in the way of establishing a laboratory in a small works is that all pumping-station men are not adapted by training to acquire the methods of bacteriological specialists. I know of one water works, however, a few miles north of Boston, which has a very intelligent engineer who makes some of the most complicated tests with a very great degree of accuracy; and we happen to have under our supervision other plants where no amount of teaching by a most competent man would get those in charge to grasp ordinary routine tests and make them with any degree of accuracy. So I think the personal element has always to be taken into consideration. But, generally speaking, I think it is a most important part of water-works management to have some sort of laboratory control over filter plants.

PRESIDENT SAVILLE. There is one matter that neither Mr. Weston nor Mr. French has mentioned, which is of considerable importance, not from the financial but from the management end, and that is the difficulty, especially in municipal plants, of getting a man who will stay with you for the money which you can pay. It takes some time to break a man in. You get a young man from Mr. Weston's laboratory, perhaps, or from some other good laboratory, or one who has had a few years' experience with the State Board of Health, and is anxious to get out and is willing to go to work for a small salary. You put up with a good many

things with him for a year or so, and get him in pretty good shape, and then he begins to be uneasy. He has become a valuable man and he wants more money. The high cost of living hits him, but the " powers that be " don't want to furnish the money to pay him any more, and then you have to begin all over again. It is a pretty difficult thing for a small laboratory to get a competent man and keep him for any length of time. I think Mr. Weston will bear me out in that.

REPORT OF COMMITTEE ON REVISION OF STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND SPECIAL CASTINGS.

The Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings begs to submit the following report.

This committee, appointed in 1912, has for several years cooperated with a similar committee of the American Water Works Association, which latter committee at the Richmond Convention in May, 1917, submitted to its parent body a report which may properly be said to be the joint work of the committees of the two associations. We cannot improve on that report, and therefore beg to submit it for your careful consideration:

The Committee on Revision of Standard Specifications for Cast-Iron Water Pipes and Special Castings begs to submit the following report:

Appointed in 1911, this committee has for several years coöperated with a similar committee of the New England Water Works Association.

In January, 1916, at a joint meeting, held in New York City, a joint committee of six members — three from the committees of each association — was appointed to prepare a tentative draft of revised specifications, to be submitted to the manufacturers for their examination and criticism. The resulting draft was forwarded to the manufacturers on May 6, 1916, accompanied by the following letter:

To the Manufacturers of Cast-Iron Pipe:

The enclosed specifications for Cast-Iron Water Pipe and Fittings, prepared by a joint committee formed from the committees of the American and New England Water Works Associations, is a preliminary draft of proposed new Standard Specifications, and is sent you for your criticism and discussion.

It is the intention of the joint committee to hold a meeting in New York City within a few months, and to invite manufacturers to appear and present in person their discussion of the enclosed specifications, or, if attendance is not possible, to submit such discussion in writing at this meeting, notice of the time of which will be given thirty days in advance of the date finally chosen.

For your information, a brief statement of the development of the specifications now sent you may be of interest. In June, 1911, the American Water

Works Association appointed a committee to revise the existing Standard Specifications for Cast-Iron Pipe, and in March, 1912, the New England Water Works Association appointed a committee for a similar purpose. Both committees at once appreciated the fact that the first object in the work should be the development of a single specification, acceptable to both associations, and which, it might be hoped, would later be adopted by all other societies and therefore become, in fact, a standard specification.

While many independent meetings of the two committees have been held during the past three years, much of the time of each committee has been spent in considering suggestions and questions submitted by the other, and January 21, 1916, a joint meeting of the committees was held in New York City, an entire day being devoted to the discussion of the modifications and revision of a tentative specification which the two committees had been considering for a number of months past. At this meeting, it was voted that a joint committee, of six members — three from the committee of each association — prepare a tentative draft of specifications to be sent to manufacturers for their discussion and criticism; and the specification now forwarded to you is the result of the work of this joint committee.

In submitting this draft of specifications for your examination, it may further be well to state that the committee recognize that the proposed specifications will involve some increase in the cost of production, but it is believed that the resulting advantages to users will be sufficient to make the slight increase in cost of no practical moment. It is therefore hoped that the manufacturers will approach the consideration of these specifications on the assumption that there is a substantial demand for a uniform outside diameter, and good reasons for a specification of the chemical character of the metal, for the relation between flexure and breaking load, and for an improved coating.

It is to be understood, however, that the present draft is altogether tentative, that the minds of the committee are open, and that this draft is now sent you for your discussion and criticism, with the hope that finally a standard specification may be developed, acceptable throughout this continent, at least, to the users and to the manufacturers of the pipe, and which will become effective at such time in the future as will reasonably allow for any necessary changes in foundry equipment.

JOINT COMMITTEE.

JOHN H. GREGORY,
N. F. S. RUSSELL,
WALTER WOOD,
Am. W. W. Assoc.

FRANK A. McINNES,
FRANK A. BARBOUR,
W. R. CONARD,
N. E. W. W. Assoc.

May 7, 1916.

On November 23, 1916, an invitation was sent to the manufacturers to meet the Joint Committee in New York on December 14, 1916, of which the following is a copy:

Dear Sirs, — In May, 1916, a copy of a Tentative Draft of Standard Specifications for Cast-Iron Pipe and Fittings, proposed by the Joint Committee of the American and New England Water Works Associations, was sent you for your examination and criticism. In the accompanying letter it was stated that a meeting, to be held in New York City, would be called at some future date, which it was hoped you would attend and present to the committee your views regarding the proposed specifications.

We now beg to advise you that this meeting will be held in the House of the American Society of Civil Engineers, No. 220 West 57th Street, New York City, at ten o'clock A.M., on Thursday, December 14, 1916, and we earnestly desire that you arrange to attend and be prepared to discuss the proposed specification.

The draft already sent you is altogether tentative, and any amendments or suggestions you may care to make will be given due consideration.

Yours truly,

FRANK A. MCINNES, *Chairman*,
New England Water Works Assoc.
Committee.

JOHN H. GREGORY, *Chairman*,
American Water Works Assoc.
Committee.

November 23, 1916.

At the meeting held on December 14, 1916, which was presided over by Mr. Leonard Metcalf, President of the American Water Works Association, there were present, in addition to the presiding officer, the following:

Representatives of the New England Water Works Association: Frank Barbour, Wm. R. Conard, Thomas H. Wiggin.

Representatives of the American Water Works Association: John H. Gregory, Frank A. Barbour, W. H. Randall, N. F. S. Russell, Walter Wood.

Representatives of manufacturers: N. F. S. Russell, U. S. C. I. Pipe and Foundry Company; Walter Wood, R. D. Wood & Co.; S. B. Brown, Warren Foundry Company; S. H. Morrison, Warren Foundry Company; R. W. Conrow, Central Foundry Company; R. R. Rust, Central Foundry Company.

The important changes from the present standard specifications proposed by the Tentative Draft of Revised Specifications, and which were the subject of discussion in the meeting of December 14, 1916, are as follows:

1. The adoption of a uniform outside diameter for all classes of pipe of the same size.

2. The specification of the permissible range of total carbon, combined carbon, silicon, manganese, phosphorus, and sulphur in the metal.

3. The requirement of a relation between flexure and breaking load in test bars.

Other less important revisions included more complete specification for coating, the including of the element of time in the hydrostatic test requirements, the addition of flanged pipe and the substitution of the word "fittings" for special castings.

After a prolonged discussion of the proposal to adopt a uniform outside diameter and of the feasibility of specifying chemical quality of the metal, — the stenographic report of which covers 128 typewritten pages, — it became evident that the manufacturers, as represented at the meeting, were opposed to the revision of the present specifications, for various reasons, including the expense incident to changes in present equipment, increased manufacturing difficulties, and the belief that the present specifications were good enough.

In order that the statements of the manufacturers as to the effect of the proposed changes on cost of production and on the technique of manufacturing might be supported by definite figures and arguments, the following motion was unanimously carried:

Moved that the manufacturers be requested to consider the tentative specifications for cast-iron pipe as prepared and submitted to the manufacturers under date of May 7, 1916, and report to the committee at a meeting to be held on March 15, 1917, the result of their deliberations, with such modifications of the specifications, paragraph by paragraph, as may seem to them desirable, together with their reasons therefor.

It was the understanding of those present that the manufacturers would discuss in detail the tentative revised specifications, and would present in writing at the meeting to be held on March 15, 1917, the results of their deliberations.

When the date of this meeting approached, it was found that the manufacturers were not prepared to submit any detailed discussion of the tentative draft of specifications, and on March 31 the following letter was received by the chairman of your committee:

JOHN H. GREGORY, *Chairman, Committee on Cast-Iron Pipe Specifications, American Water Works Association, 170 Broadway, New York City:*

Dear Sir, — Referring to the request of the committee that the manufacturers should again study the tentative specifications submitted by the joint committee of the American Water Works and New England Water Works Associations, and if necessary to propose their own specifications:

We beg to state that this question has been fully discussed at three meetings of the manufacturers, and it is the unanimous opinion that there are no essential changes, at the present, necessary in the specifications of the American Water Works Association, adopted May 12, 1908.

These specifications are not ideal, but, for practically ten years, have proven fairly satisfactory to both user and manufacturer, as evidenced by their almost universal adoption.

We would, therefore, respectfully suggest that the Specifications of the American Water Works Association, as now drafted, remain unchanged.

Yours very truly,

(Signed) WALTER WOOD.
N. F. S. RUSSELL.

The preceding letter makes evident the position of the manufacturers and the fact that not only will they not agree to any changes in the present specifications until forced to do so by the demand of consumers, but they will not coöperate with your committee to the extent of furnishing detailed reasons and figures in support of their objections to the proposed revision. Under these circumstances the only course open to your committee is to submit to the membership the tentative draft of revised specifications, and to request that after a reasonable time a ballot be taken to determine whether the Association is in favor of the adoption of the important changes suggested by these revised specifications, viz., a uniform outside diameter, chemical requirements of the metal, and a relation between flexure and breaking load.

To this end we recommend that the tentative draft of the revised specifications be printed and distributed to the members. The present draft of revised specifications is submitted to the Association for the purpose of ascertaining whether your committee is working along lines approved by the membership, and there will doubtless be material modification in the present draft before final form is reached. It is not proposed that after final adoption the new specifications should go into effect for a number of years.

Presumably the New England Water Works Committee will follow the same course as suggested in this report, and will submit the revised specifications to that Association for its consideration.

It is obvious that in view of the manufacturers' dictum that the present specifications are good enough, any further work on the part of your committee must be determined by the action of the Association. Presumably there was some reason for the appointment of this committee, and if, in the judgment of the Association, there still remains sufficient reason for a revision of the specifications, doubtless the manufacturers will meet any reasonable requirements which may be demanded, but it is to be pointed out that all members should give serious consideration to the proposed revision, and should be prepared to follow up any vote in favor of revising the present specifications by a determination to use only the revised specifications in their future work. It is believed that if, by coöperation with the New England Water Works Association and other similar bodies, a single standard specification can be developed, the result will be to the advantage of all concerned, including both the users and the manufacturers.

Respectfully submitted,

JOHN H. GREGORY, *Chairman.*
EDWARD E. WALL.
W. H. RANDALL.
F. A. BARBOUR.

May 11, 1917.

The only course open to your committee is to follow the action recommended in the above report.

It is therefore recommended that the tentative draft of specifications, and the report of the committee of the American Water Works Association, be printed and distributed to the members; that, at the next monthly meeting after such distribution, the subject be thrown open for discussion and that during the month following this discussion a Questionnaire be sent out, reading, in general terms, as follows:

With the understanding that no change will be made in the Standard Specifications for Cast-Iron Pipe and Special Castings until after

the present world war has ended, and not then until after a reasonable period has elapsed for the manufacturers to revise their equipment:

Are you in favor of the adoption of a uniform outside diameter?
Are you in favor of chemical requirements of the metal?
Are you in favor of a relation between flexure and breaking load?

It may appear advisable, after the suggested meeting for the discussion of the Revision of the Specifications, to change the above outlined series of questions, but, however this may be, the object of the Questionnaire is to obtain from the membership a mandate which will either justify the committee in continuing its work or make it evident that our Association does not desire Revised Specifications.

F. A. McINNES, *Chairman.*
F. A. BARBOUR.
W. R. CONARD.
G. A. KING.
T. H. WIGGIN.

TENTATIVE DRAFT OF STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND FITTINGS, PREPARED BY JOINT COMMITTEE OF THE AMERICAN AND NEW ENGLAND WATER WORKS ASSOCIATIONS.

(Changes from present New England and American specifications are in *italics.*)

Description of Pipe.

Section 1. The pipes shall be made with *bell* and spigot *ends or with flange ends,* and shall *conform accurately* to the dimensions given in Tables Nos. and . They shall be straight and shall be true circles in section, with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter.

Bell and spigot pipes shall be at least 12 ft. in laying length, exclusive of the bell, and flange pipes shall be at least 12 ft. in length face to face of flanges.

All classes of pipe of each size shall have the same outside diameter. All pipes having the same outside diameter shall have the same inside diameter at both ends.

The inside diameter of the lighter pipes of each standard outside diameter shall be gradually increased for a distance of about 6 in. from each end of the pipe barrel, so as to obtain the required standard thickness and weight for each size and class of pipe.

Description of Fittings.

Section 2. *There shall be two types of standard fittings, known as "Bell Fittings" and "Flange Fittings." Fittings having bell or spigot ends, or both, but no flange end or ends, shall be known as "Bell Fittings." Fittings having one or more flange ends shall be known as "Flange Fittings."*

All fittings shall be made in accordance with the cuts and dimensions given in the tables forming a part of these specifications. They shall be true circles in section with their inner and outer surfaces concentric on both run and outlet, except where intersections prevent. On all fittings the outside diameter of the barrel on each outlet shall be the same as the outside diameter of the pipe of corresponding size.

For pipes from 4 to 20 in. in diameter, inclusive, one class of fittings known as Class D fittings shall be furnished for all classes of pipe. For pipes over 20 in. in diameter, two classes of fittings, known respectively as Class AB and CD fittings, shall be furnished, Class AB fittings for Class A and Class B pipes, and Class CD fittings for Class C and Class D pipes.

Any fitting not shown in the tables hereto attached shall be known as a "Special Fitting."

Variation in Diameter of Bells and Spigots.

Section 3. Especial care shall be taken to have the *bells* and spigots of the required size. The *bells* and spigots will be tested by circular gages, and no pipe *or fitting* will be accepted *which, for any cause, does not comply with the specified joint space, except as hereinafter allowed.*

The inside diameters of the bells and the outside diameters of the spigot ends of pipes shall not vary from the standard dimensions by more than 0.06 in. for pipes 16 in. or less in diameter; 0.08 in. for pipes 18, 20 and 24 in. in diameter; 0.10 in. for pipes 30, 36 and 42 in. in diameter; 0.13 in. for pipes 48, 54 and 60 in. in diameter; *and 0.18 in. for pipes 72 and 84 in. in diameter.*

The inside diameters of the bells and the outside diameters of the spigot ends of the fittings shall not vary from the standard dimensions by more then 0.08 in. for fittings 16 in. or less in diameter; 0.10 in. for 18-, 20-, and 24-, in. fittings; 0.13 in. for 30-, 36-, and 42-in. fittings; 0.16 in. for 48-, 54- and 60-in. fittings; and 0.20 in. for 72- and 84-in. fittings.

Variation in Thickness.

Section 4. For pipes whose standard thickness is less than 1 in. the thickness of metal in the body of the pipe *shall not vary more than* 0.08 in. from the standard thickness, and for pipes

whose standard thickness is 1 in. or more, the variation shall not exceed 0.10 in., except that for spaces *the length across which in any direction does not exceed 8 in., a decreased thickness not exceeding 0.02 in. will be permitted, and for spaces the length across which does not exceed 16 in. in any direction, an increased thickness not exceeding 0.05 in. will be permitted* — both in excess of the allowances above stated.

For fittings, a variation 50% greater than that allowed for pipes shall be permitted.

Allowable Percentage of Variation in Weight.

Section 5. No pipe shall be accepted, the weight of which shall be less than the standard weight by more than 5 per cent. for pipes 16 in. or less in diameter and 4 per cent. for pipes more than 16 in. in diameter, and no excess above the standard weight of more than the above given percentages for the several sizes shall be paid for. The total weight of pipe to be paid for shall not exceed, for each size and class of pipe received, the sum of the standard weights of the same number of pieces of the given sizes and classes by more than 2 per cent.

No *fitting* shall be accepted, the weight of which shall be less than the standard by more than 10 per cent. for *fittings* 12 in. or less in diameter and 8 per cent. for larger sizes (except that curves and Y-branches may be 12 per cent. below the standard weight); no excess above the standard weight of more than the above given percentages for the several sizes shall be paid for. *The total weight of fittings to be paid for shall not exceed the sum of the standard weights of the same number of pieces of the given sizes and classes by more than 5 per cent.*

Quality of Iron.

Section 6. All pipes and fittings shall be made of cast iron of good quality and of such character as shall make the metal of the casting strong, tough, and of even grain, and soft enough satisfactorily to admit of drilling and cutting. The metal shall be made without *the admixture of any inferior material,* and shall be remelted in cupola or air furnace.

The contractor shall furnish the engineer with copies of the mill

analyses of each heat or run of metal, and shall furnish samples to the engineer for check analyses when required.

The metal for the pipes and fittings shall fulfill the following chemical requirements: Total carbon, 3 to 3.75 per cent.; combined carbon, 0.5 to 0.75; silicon, 1.6 to 2; manganese, 0.35 to 0.55; phosphorus, not to exceed 0.90; sulphur, not to exceed 0.10 per cent.

Tests of Material.

Section 7. Specimen bars of the metal used, each being 26 in. long by 2 in. wide and 1 in. thick, shall be made, without charge, as often as the engineer may direct, and in default of definite instructions the contractor shall make and test at least one bar from each heat or run of metal. The bars, when placed flatwise upon supports 24 in. apart and loaded in the center, shall support a load of 2 000 lb., and show a reflection of not less than *0.32 in. before breaking, and an increase in deflection of not less than 0.03 in. for each 200 lb. of ultimate breaking load in excess of 2 000 lb.*

The contractor shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the bars differ from those above given, a proper allowance therefor shall be made in the results of the tests.

Casting of Pipe.

Section 8. The pipes shall be cast in dry sand molds in a vertical position. Pipes 16 in. or less in diameter *may* be cast with the *bell* end up or down, unless *otherwise* specified *by the purchaser.* Pipes 18 in. or more in diameter shall be cast with the bell end down.

The pipes shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent contraction by subsequent exposure.

Quality of Castings.

Section 9. The pipes and fittings shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which, in the opinion of the engineer, unfit them for the use for which they are intended. No plugging or filling will be allowed.

Marking.

Section 10. *Each* pipe and *fitting* shall have distinctly cast upon it the initials of the maker's name, a *letter designating the class to which the casting belongs, and figures showing the year in which it was cast. When cast to order, if required by the purchaser, each pipe and fitting 6 in. or more in diameter shall also have cast upon it a serial number, designating the order in point of time in which it was cast, the serial number to be placed below the date, thus:*

1916	1916	1916
1	2	3

etc., and any initials, not exceeding four, *or a symbol,* which may be required.

The letters and figures shall be cast on the outside, and shall *be not* less than 2 in. in length and $\frac{1}{8}$ in. in relief for pipes *and fittings 10 in.* in diameter and larger. For smaller sizes of pipe, the letters may be 1 in. in length. The weight, *serial number,* and class letter shall be conspicuously painted in white on the inside of each pipe and *fitting* after the coating has become hard.

Defective Spigot Ends May Be Cut

Section 11. Defective spigot ends on pipes 12 in. or more in diameter may be cut off in a lathe, and a half-round wrought-iron or *mild-steel* band, shrunk into a groove, cut at the end of the pipe. Not more than 12 per cent. of the total number of accepted pipes of each size shall be cut and banded, and no pipe shall be banded which is less than 11 ft. in length, exclusive of socket.

Pipes may be cast with shrink-head above spigot bead, and such pipe shall not be considered as cut pipe in determining the percentage above referred to.

In case the length of a pipe differs from 12 ft., the standard weight of the pipe given in Table — shall be modified in accordance therewith.

Flanges.

Section 12. *Flanges shall be cast solid and shall be accurately faced smooth and true. Holes for bolts or studs shall be drilled, and the flanges shall be tapped where required. The contractor shall*

furnish and deliver all bolts and nuts for bolting on manhole covers. The bolts and nuts shall be of the best-quality wrought iron or mild steel, with good, sound, well-fitting threads, the nuts to be cold punched. The heads and nuts shall be hexagonal and shall be trimmed and chamfered. The heads, nuts and threads shall be of the United States Standard sizes.

Cleaning and Inspection.

Section 13. All pipes and *fittings* shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the *engineer* immediately before being *coated.*

Coating.

Section 14. Every pipe and *fitting* shall be coated inside and out with coal-tar pitch varnish. *Each pipe and fitting shall be heated to a uniform temperature of 320 degrees F., in a suitable oven, before it is dipped, and the material in the tank shall also be maintained at this temperature, and each pipe and fitting shall be kept in the bath for at least five minutes, during which time the temperature of all parts of the bath, including the bottom, shall be as specified.*

After removing the pipe from the bath, it shall be suspended or set in a vertical position until the coating has solidified.

The coating shall be of pitch, made from coal tar, distilled until the naphtha is removed, and sufficient oil to make a smooth coating, tough, elastic, strongly adhesive to the metal, tough and tenacious when cold, and not brittle nor with any tendency to scale off. Coating shall not be soft enough to flow when exposed to summer heat, nor brittle enough to crack and scale when exposed to a temperature below freezing

The pitch shall be straight-run, coal-tar pitch, which shall soften at 60 degrees F., and melt at 100 degrees F., being a grade in which distillate oils, distilled therefrom, shall have a specific gravity of 1.05. The pitch shall not contain less than 10 per cent. nor more than 18 per cent. of free carbon.

Fresh pitch and oil shall be added to the tank when necessary to keep the mixture of the proper consistency. The oil used for this purpose shall consist of heavy, coal-tar oil, with a specific gravity of

not less than 1.04 at 60 degrees F., and which shall not lose more than 5 per cent. of oil when distilled up to 400 degrees F.; not more than 40 per cent. of oil when distilled up to 450 degrees F. If the material in the tank thickens or deteriorates when used, the tank shall be emptied of its contents and refilled with fresh material when deemed necessary by the engineer.

Fittings which are too large to be immersed shall be coated with hot varnish by hand, the fittings to be heated as specified above and the coating applied immediately thereafter.

Faces of flanges and finished surfaces shall be coated with a mixture of grease and white lead immediately after they have been faced and drilled.

Any pipe or *fitting* that is to be recoated shall first be thoroughly scraped and cleaned.

Hydrostatic Test.

Section 15. When the coating has become hard, the pipe shall be subjected to a proof by hydrostatic pressure, and, if required by the engineer, they shall also be subjected to a hammer test under this pressure.

The pressures to which the different sizes and classes of pipe shall be subjected are as follows:

	Hydrostatic Pressure Lb. per Sq. In.	
Class.	Diameter Less than 20 In.	Diameter 20 In. and Over.
A	300	150
B	300	200
C	300	250
D	300	300

The full hydrostatic pressure shall be applied to the pipes for one minute on pipes 12 in. and less in diameter; for two minutes on 14-, 16-, 18-, 20- and 24-in. pipes; for three minutes on 36-in. pipes; and for five minutes on pipes larger than 36 in. in diameter.

Fittings shall also be subjected to a proof by hydrostatic pressure, provided the same is specified in the contract. If tested, the hydrostatic pressures to which the fittings shall be subjected shall be the same as those to which pipes of the same size and class would be subjected, and shall be applied for the same length of time.

Weighing.

Section 16. The pipes and *fittings* shall be weighed for payment under the supervision of the engineer after *they have been coated.* If desired by the purchaser, the pipes and *fittings* shall be weighed after their delivery. The weight so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weigh master. *The cost of weighing after delivery shall be borne by the purchaser.*

Bids shall be submitted and final settlement made upon the basis of a ton of 2 000 lbs.

Contractor to Furnish Men and Material.

Section 17. The *contractor* shall provide all tools, testing machines, materials and men necessary for the required testing, inspection and weighing at the foundry of the pipes and *fittings,* and should the purchaser have no inspector at the *foundry,* the contractor shall, if required by the purchaser, furnish a sworn statement that all of the tests have been made as specified, this statement to contain the results of *the chemical and physical tests.*

Power to Inspect.

Section 18. The engineer shall be at liberty at all times to inspect the material at the foundry and the molding, casting and coating of the pipes and *fittings.* The forms, sizes, uniformity and conditions of all pipes and *fittings* herein referred to shall be subject to his inspection and approval, and he may reject, without proving, any pipe or *fitting* which is not in conformity with the specifications or drawings furnished.

Inspector to Report.

Section 19. The inspector at the foundry shall report daily to the contractor all pipes and *fittings rejected,* with the causes for rejection.

Castings to be Delivered Sound and Perfect.

Section 20. All pipes and *fittings shall* be delivered in all respects sound and conformable to these specifications. The

inspection shall not relieve the contractor of any of his obligations in this respect, and defective pipes or *fittings* which may have passed the engineer at the foundry or elsewhere shall be at all times liable to rejection, when discovered, until the final completion and adjustment of the contract, provided, however, that the contractor shall not be held liable for pipes or *fittings* found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the pipes *and fittings* not to injure the coating, and no pipes, *fittings* or other material of any kind shall be placed in the pipes or *fittings* during transportation *or at* any time after they have *been coated.*

The contractor shall not be held responsible for any expenses or damages incurred in handling or using the castings after they have been accepted at the agreed point of delivery. Any pipe or fitting that proves defective shall, when requested, be replaced by the contractor, the measure of the damage not to exceed the value of the casting found defective. The contractor shall have the right to call for the defective casting to be returned to him at the agreed point of delivery before any allowance for the same is demanded.

Definition of the Word "Engineer."

Section 21. Wherever the word "engineer" is used herein, it shall be understood to mean the engineer or inspector acting for the purchaser, and his properly authorized agents, limited by the particular duties intrusted to them.

DISCUSSION ON REVISION OF REPORT OF COMMITTEE ON STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND SPECIAL CASTINGS.

PRESIDENT DAVIS. We will proceed to the first business in order, and that is the matter of the report of the Committee on Standard Specifications for Cast-Iron Pipe. Mr. McInnes made a preliminary report at the last meeting. Mr. McInnes, are you prepared to go on with the report on the cast-iron pipe?

MR. FRANK A. MCINNES. You are quite fully informed by the circular in regard to the reason for the discussion to-day, and I won't cover that ground. It is unfortunate that at least three of our members who took a prominent part in the conference with the manufacturers are absent, viz., Mr. Wiggin, Mr. Barbour, Mr. Gregory, I do not see. I see Mr. Conard, a member of our committee and a member of the joint committee who was present at the meeting in New York.

I regret that, due to the exigencies of the past couple of years, it has been impossible for me to attend any of the meetings.

A bone of contention has been the uniform diameter. There is, first of all, a serious question as to whether or not that is desirable. The manufacturers, as I understand it, are as a unit opposed to it; and perhaps it would be fair to say that they are opposing it on two grounds: First, that the cost would be prohibitive — and here again we have not yet found out what that cost would represent for a ton of output; and, secondly, the statement has been made, and I have no doubt it is honestly believed, and it may be a fact, that the majority of the users of pipe do not want the outside diameter. That, perhaps more than any other reason, is the cause of the action we have taken. No one would be more delighted to know the facts than the committee, and no one would more willingly give up an arduous job and stop. And we could see no better way than to ask all the members of our Association. I am very sure the manufacturers would welcome this information, as the committee would.

I do not intend to make an argument one way or the other to-day; will give my own experience. Take the chemical requirements, for instance. A number of broken pipe, perhaps a dozen, or possibly twenty, I have had analyses made, and in ninety per cent. the result showed conditions which any foundryman or user of pipe would at once say were bad. I realize fully that the chemical analysis only shows us what was in the pipe, and does not show us how the different elements were combined in the pipe; that the microscope only would show; and while I am convinced that the microscope is the ultimate solution of our problem, still I hope we may help things out by specifying a moderate, conservative chemical requirement.

And, again, the relation between flexure and breaking load. Whether or not it is enough to simply say that a pipe will break at 2 000 lb. with a deflection of three tenths of an inch. In our local work we get up against this condition a great many times, that it is necessary to go up to 2 400 lb. in order to get a deflection of three tenths of an inch; the result being iron which is very strong and very hard. We want to know whether that can be avoided or guarded against in the specifications.

It is not altogether unfair to say that we as a committee have come to a deadlock, in a sense, but we want to have you consult with us, and help us in every way possible. I know the manufacturers will be ready to do so. I have a letter just received from the president of one of our largest companies, and his concluding sentence is, — " I am sure the foundrymen want to be absolutely frank in the discussion of these specifications." I have not a doubt in the world that that is the condition, and represents the case exactly so far as the foundrymen are concerned.

I do not see that there would be much object in my going at length into this thing now. I want you to remember that if the revised specifications are adopted, there is no intention to put them into operation during the war, or during the period after the war necessary for readjustment.

Mr. President, I move that any foundrymen or makers of pipe, or others interested in producing pipe, be given the privilege of the floor in the discussion this afternoon.

(The motion was seconded and carried.)

PRESIDENT DAVIS. Now, then, in accordance with the motion, I will call on any manufacturers, makers, or others who are prepared to take part in this discussion. Possibly there may be some written discussions.

MR. CHARLES R. WOOD (of R. D. Wood & Co.). We should like to know just what is going to be done. What is going to happen now? We do not quite understand. Our firm is not ready to discuss them, but want to know what is to be the procedure. What do you expect to do with this tentative draft? Are you going to get up a questionnaire and hand it around to all the members?

PRESIDENT DAVIS. I take it that that is covered on the sixth page of the report of the committee, — near the top of the sixth page:

> " It is therefore recommended that the tentative draft of specifications, and the report of the committee of the American Water Works Association, be printed and distributed to the members; that, at the next monthly meeting after such distribution, the subject be thrown open for discussion, and that during the month following this discussion a questionnaire be sent out, reading, in general terms, as follows:
>
> " ' With the understanding that no change shall be made in the Standard Specifications for cast-iron pipe and special castings until after the present world war has ended, and not then until after a reasonable period has elapsed for the manufacturers to revise their equipment,
>
> " ' Are you in favor of the adoption of a uniform outside diameter?
> " ' Are you in favor of chemical requirements of the metal?
> " ' Are you in favor of a relation between flexure and breaking load? ' "

The reference there to " the next monthly meeting," means the meeting we are holding to-day. Now, I take it this meeting is one for general discussion, and the committee recommend that following this meeting a questionnaire be sent out covering additional points.

MR. WOOD. Then I should like to suggest that a representative of the manufacturers be given a chance to discuss with the committee the exact wording of that questionnaire, if the committee sees fit — of course if they do not want to, they don't have to, but I think it would be a very good thing. While the manufac-

turers may not have responded to the previous suggestions of the committee, I think they would be glad to suggest one or two questions they would like to ask.

The broad question the manufacturers want to know is, whether there is any demand for a change in the specifications. I think Mr. McInnes said he was not sure there was.

It may be of interest to say that we have just received a copy of the new standard British specifications, which they have adopted after ten or fifteen years' hard work. After the war is over we want to get specifications in this country that will enable us to go into the world market in competition with the British and German manufacturers; therefore, we suggest that any standard specifications in this country be drawn up with the idea of enabling us to compete with the foreign manufacturers in every country, as we are going to be more of an exporting nation than ever before after this war is over; that is one thing the manufacturers of pipe are very anxious to have the committee bear in mind. Whether there is anything in the specifications that we would object to, or would want to add, we would not like to have the matter pushed forward too fast. We would not wish the committee to delay action exactly, but we want to have it go slowly and carefully. If the questionnaire is going to be sent out, we should be glad if some one of the manufacturers could see a list of those questions before they were sent out. There may be something we could suggest that would be of value.

PRESIDENT DAVIS. Mr. McInnes, have you any comments to make on that suggestion?

MR. MCINNES. We are only trying, Mr. President, to find out what the manufacturers want to know. What they want to know, we want to know. I do not see what additions are necessary. A simple question will be given, and a very plain answer will be expected. And if the answer is adverse, then we stop as a committee; if it is favorable we will get up against our friends, the makers of pipe, again. And we certainly would not expect to go too fast.

There is one other thing which has come up very recently. That is as to whether the engineers in England have adopted the outside diameter. That is of importance and interest to us. I

have written for a copy of the English specifications, but I have not received it.

I do not see why this questionnaire should be delayed.

MR. WOOD. Mr. President, it is not necessary to delay it, but we would like to make one or two suggestions about the questions which are to be asked. In other words, it will be very unfortunate if the manufacturers are forced to get out an elaborate pamphlet objecting to the specifications. And, if they go out as they are, the manufacturers will be forced to take that action, and send to every member of the New England and American Water Works Associations a statement of what will happen. We should not be put in that position. If we were allowed to put one or two questions in that questionnaire ourselves — or suggest one or two, rather, I think it will work out very easily.

MR. MCINNES. I am sure, as one, I should welcome a conference with them before we put out the questionnaire; but it must be entirely in our hands. If they can advise us in a way which we think worth while, we shall be glad to adopt the suggestions.

PRESIDENT DAVIS. Mr. McInnes said he would like to get the thought of the Association on that suggestion. Apparently, as I understand it, it is that if this questionnaire is sent out, that it be after a consultation with representatives of the manufacturers. Are there any suggestions or comments on that suggestion as made by Mr. Wood? As I understand it, — if there is no comment, nothing to be said on the matter, — the committee has the framing of the questionnaire in their hands; and all they are asking from this meeting to-day, as I understand the matter, is authority to send it out. Am I correct, Mr. McInnes?

MR. MCINNES. I think not exactly, Mr. President.

PRESIDENT DAVIS. Won't you correct me, then?

MR. MCINNES. I think we voted at our last meeting that the questionnaire be sent out, did we not? This is simply a discussion, to help the thing along, to get the members present from both sides to express their views.

PRESIDENT DAVIS. Then did the meeting last time vote on the wording of the questionnaire, — the three questions that are given here?

MR. MCINNES. They might be changed.

PRESIDENT DAVIS. That is not mandatory? That is still optional with the committee?

MR. MCINNES. Yes, sir. If Mr. Wood could suggest a little more definitely to whom we should apply, so that we could know whom to deal with, I should personally be very glad to do it that way. But I think there are a lot of gentlemen here who should tell us what they think about it.

PRESIDENT DAVIS. I do not want to suggest closing the discussion prematurely, but I think there are others here who would like to talk on it. Apparently Mr. McInnes is very anxious to have them heard.

MR. CHARLES W. SHERMAN. Mr. President, I do not know as I have very much to say on the matter, and I certainly do not think we want to instruct the committee which has been working on this matter so long, and has it so well in hand. But I think the committee as a whole will agree with Mr. McInnes's sentiment, — that they will welcome any suggestions from the manufacturers. Nevertheless, I think it ought to be left entirely in the discretion of the committee whether they will accept the suggestions or merely consider them. I think the committee should make up such a questionnaire as they think ought to go out. But I do think it would be a great help to the committee, as Mr. Wood suggested, if the manufacturers would frame such questions as they think ought to go out, and discuss those questions with the committee. I, for one, would be glad to see the questionnaire expanded to cover anything which would help in reaching a final decision on this matter.

MR. J. M. DIVEN. I should like to take exception to one remark that was made. That is, if the amswers are negative, the work of the committee will end. It seems to me that the work should continue whether the change is made or not. I think that the specifications of the two associations should be reconciled so that there will be only one set — a real standard.

Then, for the benefit of the committee, I would say that personally I object to the use of the word " fittings." It is going to be confusing to the minds of the water-works people. We have always understood the word " fitting " to mean steam fitting, and so forth. Special castings is not the right term. Some word

better than "special casting" or "fitting" should be devised. I think the committee should consider that.

PRESIDENT DAVIS. What would you suggest?

MR. DIVEN. I haven't anything to suggest. But I do not like either word. I should prefer the old word to the new, because the new word is confusing. It will give a new use to a word that we have used all our lives for something else.

MR. A. B. COULTERS. Mr. President, I should like to ask what word has been used by the American Association to cover that article.

MR. WOOD. "Special castings," they call it.

MR. SHERMAN. It seems to me on that same point that the term "special castings" is worse than the word "fittings." I think Mr. Diven's comment has some force, but when it comes to regular specials, and special specials, that is worse than using the word "fittings," even though it also is used for steel and wrought-iron pipe.

I think the other point probably is well taken. The committee ought not to cease its labors, no matter what the answers are, until we get new specifications. There are inconsistencies in both sets of specifications as they now are. They are along different lines, quite materially different, and it ought to be possible to bring them together without any material change of the bases on which they are at present made up if the changes suggested by the committee are not adopted. Their inconsistencies at least ought to be eliminated from both sets of specifications.

MR. MCINNES. I do want to say that some of the committee are getting old, and can't live much longer.

PRESIDENT DAVIS. I take it the committee is continued until it makes its final report and is discharged. So that I assume the committee will continue anyway. Mr. Conard, you are a member of this committee.

MR. W. R. CONARD. Well, Mr. President, I was rather in hopes that we should hear from some of the other members of the Association before any of the other members of the committee had anything to say. I do not know that there is anything that I as a member of the committee could add particularly to what Mr. McInnes has already said about the feelings of the com-

mittee, in that we should like very much to know whether the New England Water Works Association as an association desires the committee to actually revise and get out an entirely new set of specifications, or whether they want us to proceed and reconcile the present specifications, or endeavor to reconcile the present specifications with those of the American Water Works Association. Unless entirely new specifications are to be gotten out, some such reconciliation should be made, most assuredly. As some — at least the older members of the Association — may recall, the present specifications of the New England Water Works Association have been in operation for quite a number of years. They were admittedly not perfect when they were produced. And it was thought at the time that, as time elapsed, as the state of the art, both from the manufacturing standpoint and from an engineering standpoint, might indicate that there were changes and revisions desired, it might be well to make changes. And it has been a matter now of over five years — practically six years — since the committee was appointed the last time, and evidently the thought at the time the committee was appointed was that the time had arrived when there should be some revision. But the committee have been working along, and matters have reached the point where the general membership have indicated to the committee broadly what their desires are, and the question has arisen in the minds of the committee whether they want a complete revision or a reconciliation with the American Water Works specifications.

As to the questions or discussion which have arisen at the joint committee meetings between the committees of the American Water Works Association and the New England Water Works Association, the last joint meeting that was held, as you know by the printed letter that was sent out, after discussing the various phases and provisions of the tentative specifications, there was a motion adopted and agreed to by the representatives of the manufacturers that were present at that time, that after a lapse of time another joint meeting would be held at which the manufacturers would be permitted to present to the joint committee their favorable or unfavorable comment, and if unfavorable their objections to the various provisions of the specifications. One, the

probable cost of making the changes necessary to make pipe for the various nominal diameters and uniform outside diameter; another, the provisions for obtaining something in the way of uniform metal, either by means of chemical specifications or physical qualities, or both; others of lesser importance, yet of sufficient importance, for the committee to have information on, — that of the provisions for the hydrostatic test and the provisions for coating.

On the matter of uniform outside diameters, and obtaining variations in classes by means of varying the core diameters, there have been in the last few years adopted by some of the manufacturers of this country cores for small pipe similar to those in force in some of the European countries, — England, and also on the Continent, — known as "Skilley" cores, made from horse droppings. Others of the manufacturers have adopted what is known as the "Fletcher core." This is a paper preparation that they use in place of the hay rope.

Those two methods of making cores will militate somewhat against varying the core diameters. They have been adopted by the manufacturers with a view to producing a better pipe, and the manufacturers are to be commended for their endeavors to produce better pipe, and therefore are entitled to consideration in some of their contentions.

Mr. McInnes spoke also of the question as to whether the users in general wish a uniform outside diameter, or whether they are satisfied with the present variations as provided in the present specifications. That is a matter that the questionnaire should answer.

The matter of chemical requirement: If the manufacturers will show to the committee that that is absolutely impracticable, it would seem as though the physical requirements should be modified to the extent that would obtain more nearly uniform pipe among the various manufacturers. The pipe coming from one plant should be as nearly the same as is possible to that coming from another plant. That made in the eastern section of the country should be as nearly uniform in physical qualities to that made in the southern.

The matter of hydrostatic test: If the hydrostatic test is to

perform its proper functions and to be a hydrostatic test, if with the present equipment that the foundries have they can't give a sufficient length of time to get the static test, they should provide themselves with sufficient additional equipment to do it and make the necessary, if necessary, rearrangements in their plants to do so. And if it is necessary in the matter of production cost to increase the cost of the pipe to the purchaser, the purchaser should be willing on his part, if he considers the hydrostatic test of value, to pay the amount necessary, or the increased cost.

In the matter of coating, that is such a broad question, and one that presents so many, many phases, that I hardly feel prepared to discuss it at this time.

MR. WILLIAM F. WOODBURN. The thought comes to me right now that there may be a good many of the superintendents present who may not be familiar with all of the ideas as suggested by the committee. For instance, the uniform outside diameter. Would it not be well to have the chairman of the committee explain to the superintendents present their idea of suggesting this uniform outside diameter; and then let us hear from some of the superintendents as to whether they feel that it is necessary to call for a uniform outside diameter.

PRESIDENT DAVIS. I think Mr. Woodburn's suggestion is a good one. He suggests that the chairman of the committee explain the reason why the uniform outside diameter has been made, and then ask the superintendents here who have had practical difficulties to give offhand their experiences along those lines, or their thoughts about it.

MR. MCINNES. The general idea of the outside diameter is very simple. It is that every pipe and fitting of one nominal diameter will fit in every other one, that we shall not have the trouble we have had in the past of finding a B pipe which it is impossible to connect with a D pipe or an E pipe; but every spigot will enter every bell of the same nominal size. In other words. every 24-in. pipe of every weight shall enter every other 24-in. pipe. That is all there is to the uniform diameter. It sounds very simple and easy, but from a foundryman's point of view it is difficult, without any doubt.

PRESIDENT DAVIS. Mr. Woodburn's further suggestion was

that if there are any superintendents here who have had experience or have ideas along that particular line, they shall give them to us.

MR. WOODBURN. What I wanted to bring out was, if there are any superintendents here who feel that they would like to couple pipe designed for 173-lb. pressure on to Class A pipe, designed for 43-lb. pressure. In other words, aren't they taking a chance that they are unable to take at the present time in putting light pipe in the line where heavy pipe should go? If they are to be able to couple two pipes together, whether they would not do it. Whether it is worth the additional expense as suggested by the committee.

PRESIDENT DAVIS. Mr. Gear, we haven't heard from you.

MR. PATRICK GEAR. Mr. President, my dear friend, Mr. Diven, said that we should change the word "special casting." I agree with him. Call it some other name, because if we find a special casting that does not fit and we call their attention to it, they will say that it is a special casting. Now, it is kind of provoking when a fellow is out a couple of miles from his shop, and he gets out there on a tee that is broken, where he has a line shut off, and he has a tee and a sleeve, and a piece of pipe, and he gets the pipe out and it is supposed to fit, and then he finds that it won't go. Now, if there is any way that the manufacturers could make the outside diameters all the same size, — whether A, B, C, D, E, or F, — they will confer a great blessing upon us and we will take our hats off to them every time we meet them. They can do that without any great expense to themselves. And if every man who makes a special casting, whether a tee, gate or sleeve, will make them all so that they will fit a B pipe or an E pipe, then a lot of our troubles will be taken care of.

Some years ago we would get a carload of pipe from the foundry. It would be a Class E pipe and be all right and fit. It would be good material and you could cut it and it would break where you intended to cut it. About three years ago I wanted some pipe in a hurry, and I sent for a carload, and it came. I don't know how it happened that it was not all broken up when it got there. The order was cancelled on all that pipe, and we had to send our order down to Mr. Conard to inspect it. A few years ago we got good pipe without inspection; now we can't. I don't know why.

Whether the manufacturers want Mr. Conard down there to inspect all their pipe or not I do not know, but he has got to be there if we want good pipe. He sends me a list of all the pipe that he throws out, and the different troubles that were in the pipe, and the rejections that we have had — selecting your army is nothing compared to our rejections.

If the manufacturers can make a good pipe, that won't break when you cut it, and the hammer won't go through it — by the way, this order I spoke about, I wrote to the concern that made the pipe and they couldn't understand it. So I got a lot of it in lengths about a couple of feet long and shipped it down to them, and they thought it was stove pipe. I did myself. The manufacturers can make a better pipe, and if this committee can get a pipe which will be uniform on the outside, and all classes of pipe will fit all classes of fittings, and if the men who make the fittings and who make the gates will make the gates so that they will fit all other pipe, a great deal of our trouble will cease.

We want a uniform outside diameter for all pipe, no matter what the class is, and a uniform inside diameter for all fittings, — we want the same size to fit any kind of a pipe.

Mr. James W. Dillon. I do not suppose there is a waterworks superintendent present, or anywhere in the world, who has not had his troubles with misfit pipe. But I am thinking that if the outside diameter is to be the diameter of the heaviest pipe, what kind of a time we would have in connecting one of these new pipes with the old Class A pipe.

Mr. Frank L. Fuller. I have had very little trouble in the experience I have had with pipes going together. The greatest trouble that I can remember is in connecting some of the Builders Iron Foundry's quarter bends on to the pipe that was provided for that purpose, especially on entering a reservoir. Several times there we have been obliged to cut off the bead and perhaps have the pipe turned down. But the ordinary straight pipe, and the ordinary specials that have been furnished, largely by the Builders Iron Foundry, to connect with this straight pipe, I have had very little trouble with. Oftentimes I have thought the bells on the gates were rather large, and required pretty large joints, but had no serious trouble after the joints were made. So

that while this uniform pipe diameter probably would be a good thing, I have had very little trouble myself with the old style of things. The ordinary joint that I have used has been $\frac{3}{8}$ of an inch, I think, and that is sufficient to allow for all necessary variations in the size of the pipe, in the bead at the spigot end of the pipe.

MR. COULTERS. Everybody knows that before the adoption of the standard pipe specifications by both the American and New England Associations, the pipe specifications were in a chaotic condition. Every manufacturer had specifications of his own, and he hated like fury to deviate from them in the slightest way.

We were in the same predicament. Two manufacturers would rarely adopt the same specification, and the result was that there was trouble. Nobody denied it. There was difficulty in making fittings go together. But after the adoption of the specifications, the Builders Iron Foundry knew what was to be, — at least we knew what the specifications were. We followed that out, and the result has been that where we used to have fifteen or twenty complaints in the run of a month, and probably somewhere in the neighborhood of seventy-five or one hundred during a season, regarding the failure of our fittings to go together with pipe of other makes, we have not in the last four or five years had a single one which upon investigation proved that our fittings were to blame.

Previous to the adoption of the specifications, we were to blame for at least a part of the trouble that always prevailed. Since the specifications have been in use we have had some complaints. One or two that I have investigated have been where our bells were not large enough to accommodate the spigots on the pipe with which they were to be used. On investigation it was found that the spigot bead on the pipe was large, and that while the form laid down in the specifications had apparently been adopted it had not been carried out. The result was that instead of a spigot bead having at its extreme end a corner having a radius of $\frac{1}{8}$ in. or $\frac{1}{4}$ in. it had been carried out to a misshapen point which increased the diameter of the spigot sufficiently to prevent it being entered into the bell of any fitting; our make or any other. The bell was all right in this case, the spigot was to blame.

But to consider this thing from the manufacturers' standpoint. We are all interested in the welfare of the good old U. S. A. We understand that after this war is over we shall be called upon to furnish a good deal of material now furnished by others.

Now, if we are to do that it seems to me that we should do something looking toward the standardization of the pipe specifications of this country. This talk of changes does not perhaps affect the Builders Iron Foundry so much as it does manufacturers of straight pipe. There are some men who have been trying to make us believe that the change to a standard outside diameter is a very serious matter. It is apparent to me that the committee has been trying to find out what the objection is on the part of the manufacturers to making changes. That is, what the expense is likely to be and whether or not, in the light of that expense, a change is warranted. For my part it seems to me that it is a matter of having either several sets of patterns for different classes of pipe, or else having several sets of arbors to make cores on. In the first case, it would mean that the number of patterns for each nominal diameter of pipe would be limited to one where as now there are from two to four depending upon the completeness of the equipment possessed by any manufacturer. If we were to make the outside diameters for all classes of pipe of the same nominal diameter equal, the difference in the weight of pipe would be taken care of by the diameter of the core placed in the mould. In the case of a Class A pipe, the core would be larger in diameter than would be the case where a Class B pipe was to be made. The differences involved, however, are not great enough to call for anything more than a little extra care and a slightly increased amount of material in making cores on the same arbor for any one of several classes of pipe.

I cannot understand from anything that has been said what the objection is to making changes if they are really needed. If there are those among us who possess information along this line, now is the time to give us the benefit of it. But let us settle this matter. I believe that the adoption of a standard outside diameter and a standard size of bell would be a very good thing for us, provided it is deemed necessary to depart from the present specifications. But whatever we do let us settle the matter so

that it will stay settled. Let us settle it so that the thing will be of some benefit not only to the New England Water Works Association but to the American Water Works Association and to the country in general. Something that will conform at least in essential details with another specification which has already been put into effect by the British Association. I do not know what their specifications are and am not advocating the adoption of them, but the action of British Association specifically shows that after due deliberation they have arrived at a definite conclusion, and it seems to me that we should do the same.

MR. GEAR. Speaking of special castings, I didn't know but Mr. Coulters might take offense. But the trouble with special castings that I have run up against has not been with those of the Builders Iron Foundry. I never have had any trouble with his special castings. The trouble I had was when the special castings were bought from the foundry which furnished the pipe; and we probably did not use them all in that line, we may have had a few left, and when we came to use them on some other line we got into trouble. We have had no trouble with the castings of the Builders Iron Foundry. When I mentioned special castings, I did not have reference to the Builders Iron Foundry, because I never had any trouble with theirs.

PRESIDENT DAVIS. Are there any other comments or remarks?

MR. H. V. MACKSEY. I quite agree with the line of argument given us by the Builders Iron Foundry Company. It seems to me unreasonable on the part of the manufacturers to simply say, "We won't, and we would like to know why you want us to; or we can't and we won't tell you the reason why." If their attitude is that "we are only going to make pipe thus-and-so, and we have let you go as far as we ever intend to in dictating to us what you shall use and what you shall purchase," why, let them have the courage to say so. If that is their way of looking at it, we should be glad to know it. And if we can't budge them we will take our medicine. But it seems to me that at the present time they are showing either a lack of courage or a lack of knowledge of their own business. They surely can't believe that the water-works superintendents, members of this Association, intend to insist upon anything that is unreasonable, however great an accommo-

dation it would be to us to have it. But if we are asking for something unreasonable, tell us why. They do not care about the additional cost, because for every dollar they put into the pipe they put on the usual trade profit, and the more money they get into the pipe the greater their profit. They can't expect us to believe that, you know. The situation is this: That for some reason or other they are either too obstinate or too ignorant to do what we want or explain why they cannot do so.

MR. WOOD. When there is any strong outburst from the superintendents of water works asking for new specifications they will get them, and not until then. I have not heard more than about five men say that they wanted new specifications in these last six or seven New England meetings that I have attended. And I think when you get these questionnaires out you will be surprised to see how many come back saying the present ones are good enough.

As to whether you would rather have one outside pattern than a thousand for cores it is very easy to understand. I don't think it is necessary to go into details on that.

MR. MACKSEY. I agree with what the gentleman has just said, — that when we really want it, we will get it, — and that they are going to lay back and make us show that we have got to have it. Why can't they do this in a polite way without waiting for us to fight and demand, or have a general uprising or Bolsheviki riot? Why not do things in the more businesslike manner?

PRESIDENT DAVIS. We have heard a good deal about the history attending the conferences between the manufacturers and the committee in the past. I do not suppose any of us here have any first-hand information, but I assume that, in so far as this meeting is concerned, the manufacturers and the superintendents through their committees are going to get together. And I heard no objection to Mr. Wood's suggestion that this questionnaire go out after there has been a conference between the committee and the manufacturers as to the nature and kind of the questions. So that I assume that this meeting now is in the way of finding out whether there is or is not a demand for a change, and if there is a demand for a change whether it will be along the

three-point line suggested by the questionnaire, or by such other questions as the manufacturers may suggest and the committee may adopt. Is there any further discussion? Am I right, Mr. McInnes, in assuming that no action is necessary —

MR. MCINNES. I am sure the committee will welcome any suggestions from the manufacturers, to be incorporated, if the committee thinks helpful, in our questionnaire.

PRESIDENT DAVIS. I understand that at the last meeting the idea was adopted of sending out the questionnaire, and the committee is going to do that after conference. Are there any further remarks on this matter of uniform pipe specifications? [*No response.*]

PROCEEDINGS.

Annual Meeting.

Hotel Brunswick,
Boston, Mass., January 9, 1918.

The President, Mr. Caleb M. Saville, in the chair.

The following members and guests were present:

Honorary Members.

E. C. Brooks.
R. C. P. Coggeshall.
Desmond FitzGerald.
F. E. Hall.
G. A. Stacy.
F. P. Stearns. — 6.

Members.

F. A. Barbour.
J. F. Barrett.
A. E. Blackmer.
Bertram Brewer.
J. C. Chase.
F. L. Cole.
J. E. Conley.
C. E. Davis.
A. O. Doane.
E. D. Eldredge.
Frank Emerson.
S. F. Ferguson.
F. L. Fuller.
G. Ferullo.
Patrick Gear.
H. T. Gidley.
H. A. Hanscom.
A. C. Howes.
W. F. Howland.
E. W. Kent.
Willard Kent.
S. E. Killam.
G. A. King.
John Knickerbacker.
P. J. Lucey.
F. A. McInnes.
F. E. Merrill.
Leonard Metcalf.
A. E. Pickup.
C. R. Preston.
Ransom Rowe.
G. A. Sampson.
C. M. Saville.
C. W. Sherman.
J. Waldo Smith.
W. F. Sullivan.
H. A. Symonds.
L. D. Thorpe.
D. N. Tower.
W. H. Vaughn.
R. S. Weston.
F. B. Wilkins.
F. I. Winslow. — 43.

Associates.

Bond, H. L. Co., by F. M. Bates and F. W. Mattheis.
Builders Iron Foundry, by G. H. Lewis.
Byers, A. M., Co., by H. F. Fiske.
Central Foundry Co., by W. H. Feltt.
Chapman Valve Mfg. Co., by J. J. Hartigan and C. E. Pratt.
Dixon Crucible Co., by H. A. Nealley.
Eddy Valve Company, by H. R. Prescott.
Edison Mfg. Co., by H. L. B. Watson.
Hersey Mfg. Co., by W. A. Hersey and J. H. Smith.
Hammond Process Co., by J. L. Flynn.
Lead Lined Iron Pipe Co., by T. E. Dwyer.
Ludlow Valve Mfg. Co., by A. R. Taylor.

National Meter Co., by J. G. Lufkin and H. L. Weston.
Neptune Meter Co., by H. H. Kinsey.
Pittsburgh Meter Co., by J. W. Turner.
Thomson Meter Co., by S. D. Higley and E. M. Shedd.
Union Water Meter Co., by H. W. Jacobs and E. D. Otis.
Water Works Equipment Co., by W. H. Van Winkle.
Wood & Co., R. D., by C. R. Wood.
Schramm & Son, Chris D., by J. W. Gleeson. — 26.

GUESTS.

MASSACHUSETTS. *Charlestown.* Mr. Teague.
Boston. H. P. J. Earnshaw and Samuel Prescott. — 3.

The Secretary, Mr. Willard Kent, presented his annual report as follows:

REPORT OF THE SECRETARY.

JANUARY 1, 1918.

Mr. President and Gentlemen of the New England Water Works Association, — The Secretary submits herewith the following report of the changes in membership during the past year, and the general condition of the Association.

The present membership is 1 002, constituted as follows: 14 Honorary, 901 Members, and 87 Associates, there being a net loss for the year of 41. The detailed changes are as follows;

MEMBERSHIP.

January 1, 1917.	Honorary Members	17		
	Died	3		
		—		14
January 1, 1917.	Total Members		942	
	Resigned	47		
	Dropped	27		
	Died	15		
		—	89	
			—	853
	Initiations:			
	January	4		
	February	6		
	March	3		
	June	3		
	September	11		
	November	4		
	December	2		
		—		33

	Reinstated:				
	Member resigned in 1911	1			
	Members dropped in 1916	5			
		—	6		
	Elected 1916, qualified 1917		9		
			—	15	
				—	901
January 1, 1917.	Total Associates		84		
	Resigned	3			
	Dropped	1			
		—	4		
			—	80	
	Initiations:				
	March	1			
	September	2			
	December	2			
		—	5		
	Reinstated:				
	Associates dropped in 1916		2		
			—	7	
				—	87
January 1, 1918.	Total membership				1 002
January 1, 1917.	Total membership				1 043
	Net loss				41

The Secretary has received and paid to the Treasurer,		$7 610.70	
Of this amount, the			
Receipts from initiation fees were	$217.00		
From dues of members	2 716.00		
From dues of members, fractional	29.25		
From dues of members, past	15.00		
		$2 977.25	
From dues of Associates	$1 275.00		
From dues of Associates, fractional	26.25		
		1 301.25	
Total from dues			$4 278.50
From advertisements			1 702.50
From subscriptions			300.75
From JOURNALS			419.00
From sundries			909.95
Total as above			$7 610.70

There is due the Association at this date:

For advertisements	$85.00
For specifications	.60
For JOURNALS	2.50
For reprints	58.50
Total amount due	$146.60

Respectfully submitted,

WILLARD KENT, *Secretary.*

On motion of Mr. Frank L. Fuller, it was voted that the report of the Secretary be accepted and placed on file.

The Treasurer, Mr. Lewis M. Bancroft, submitted the following as his annual report:

CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Receipts.

Dividends and interest		$231.15
Initiation fees	$217.00	
Dues	4 061.50	
Total received from members		4 278.50
JOURNAL:		
Advertisements	$1 702.50	
Subscriptions	300.75	
Sale of JOURNALS	419.00	
Sale of reprints	14.45	
Total received from JOURNAL		2 436.70
Miscellaneous Receipts:		
Sale of "Pipe Specifications"	$20.20	
Dinners	768.00	
Certificates of membership	34.50	
Buttons	6.75	
Index	1.00	
Meter rate sheets	9.25	
June excursion	24.80	
Portland Convention Committee	23.17	
Boston Society of Civil Engineers	100.00	
Manufacturers' Association	1 000.00	
Miscellaneous	4.65	
Total miscellaneous receipts		1 992.32
Total receipts		$8 938.67

LEWIS M. BANCROFT, *Treasurer*,

In account with the New England Water Works Association.

RECEIPTS.			EXPENDITURES.		
1917.			Bills paid		$8 253.65
Jan. 1.	Balance on hand	$2 419.57			
	Received of Willard Kent, Secretary	7 610.70	BALANCE ON HAND.		
	Interest on bonds and deposits	225.80	People's Savings Bank	$2 000.00	
	Manufacturers' Association	1 000.00	Mechanics Savings Bank	403.66	
	Portland Convention Committee	2.17	First National Bank	648.70	
	Boston Society of Civil Engineers	100.00	Liberty Trust	52.23	
					3 104.59
		$11 358.24			$11 358.24

ASSETS AND LIABILITIES.

ASSETS.			LIABILITIES.	
Cash balance in banks		$3 104.59	Accounts payable:	
Bonds Nos. 2642 and 2644 Lake Shore & Mich. Southern R. R., due May 1, 1931. Book value, $1 815.00. Market value		1 695.00	Samuel Usher	$865.20
Accounts receivable:			Brunswick Hotel Co.	174.50
JOURNALS	$2.50		A. D. Handy	12.00
Advertisements	85.00		Boston Mailing Co.	1.00
Specifications	.60		Fleming-Hughes-Rogers Co.	12.75
Reprints	58.50		Miss Joan M. Ham	104.05
		146.60	Boston Society of Civil Engineers	137.50
			John A. Lowell Bank Note Co.	2.40
			Hobbs & Warren	6.73
			D. Gillies' Sons	26.00
			Surplus	3 604.06
		$4 946.19		$4 946.19

READING, January 9, 1918.

LEWIS M. BANCROFT, *Treasurer*.

Expenditures.

JOURNAL:			
Advertising agent's commission		$233.00	
Plates		58.21	
Printing		1 893.30	
Editor's salary		300.00	
Editor's expense		27.75	
Reporting		194.28	
Advance reports		27.50	
Reprints		140.00	
Envelopes and postage		82.48	
			$2 956.52
Office:			
Secretary's salary		$200.00	
Secretary's expense		40.33	
Assistant to Secretary, salary		756.60	
Assistant to Secretary, expense		229.08	
Rent		550.00	
Printing, stationery, and postage		334.91	
Membership lists		264.79	
			2 375.71
Meetings and Committees:			
Stereopticon		$20.00	
Dinners	$669.82		
Cigars	44.70		
Music	48.00		
		762.52	
Printing, stationery, and postage		136.41	
Reporting		49.60	
			$968.53
Treasurer's salary and bond			67.50
Certificates of membership			3.90
Flowers			31.70
Income tax			1.71
Brackett medal			6.00
Standard specifications			3.00
Furniture			486.91
September convention			772.93
Index			579.24
			$8 253.65

On motion of Mr. Desmond FitzGerald, it was voted that the report of the Treasurer be accepted and placed on file.

Mr. E. D. Eldredge, chairman, submitted the following report of the Auditing Committee:

REPORT OF AUDITING COMMITTEE.

BOSTON, MASS., January 8, 1918.

We have examined the accounts of the Secretary and Treasurer of the New England Water Works Association, and find the books correctly kept and the various expenditures of the past year supported by duly approved vouchers.

Respectfully submitted,

E. D. ELDREDGE,
A. E. PICKUP,
BERTRAM BREWER,
Auditing Committee.

On motion of Mr. Desmond FitzGerald, it was voted that the report of the Auditing Committee be accepted and placed on file.

OTHER COMMITTEE REPORTS.

Mr. Frank A. McInnes for the Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings, submitted a report which is printed in full on page 70.

On motion of Mr. Charles W. Sherman, it was voted that the report of the Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings be accepted, its recommendations adopted, and the committee continued.

Mr. Sherman suggested that the printing proposed by the committee be done in the JOURNAL, so that it may be made a matter of permanent record, rather than in a separate pamphlet which may easily be lost or destroyed. The President said the suggestion seemed to the chairman a good one, and if no objection was made it would be adopted.

MR. FRANK A. BARBOUR. I think I am a member of the Committee on Leakage; indeed, I think I am the chairman of that committee, although I had really forgotten that there was such a committee until I was reminded of it a few minutes ago. Nothing has been done during the present year, and I somewhat question

whether anything will be done until the war is over, certainly not so far as I am personally concerned. Some time ago I outlined a very considerable amount of work, and I endeavored to unload some of it on our honored President, and some of it on the incoming President, but I never quite got around to it. It may be that during the coming year I may find time, but if not, it will have to wait.

THE PRESIDENT. The Chair would like to say that Mr. Barbour has done all the work of the committee that has been done, and a year ago — I think it was — he made a very able preliminary report, but since that time nothing has been done. Do you care to make any suggestion, Mr. Barbour, as to having the committee continued?

MR. BARBOUR. I don't think it will do any harm to continue the committee.

MR. ROBERT SPURR WESTON. I am secretary of the committee of which Mr. Whipple is chairman, on Water Purification Plant Statistics. We would like to continue our work. We intended to have a report ready at this time, but, owing to the absence of Professor Whipple in Russia, and other matters connected with the war, the committee has been able to meet but once this year. We have a large mass of data which we would like to present at another time. When it can be presented is very uncertain, but we would like to be continued.

THE PRESIDENT. If there is no objection that course will be taken.

ADDRESS BY THE RETIRING PRESIDENT.

THE PRESIDENT. The next thing upon the program is the annual address by the President. What I have to say, however, will be rather in the nature of an informal talk than an address. There are one or two things that have happened this year that it may, perhaps, be well to speak of. It is our custom not to mention the names of members of the Association in thanking them for any special service rendered, so I will dodge that rule by thanking the committee of the Manufacturers' Association collectively for the help and the interest shown by them at the annual convention. It also seems to me that the loyal and substan-

tial support that was given by the associate members at the last meeting, in the matter of the increased dues, is a very strong indication of the virility of this Association, and that the fact that those members came forward as they did, with their help, is worthy of special mention.

There is also the matter of the necessity of attracting young men to our Association, in order to interest them in our work and keep our ranks full. We do not need to be told that time flies, and that the present members of the Association are rapidly growing older. As I look down across the tables here I see the same faces that I have seen for many years, and the younger men do not seem to be coming in as they should to take our places. So I would respectfully suggest to the incoming administration that, if possible, in some way particular inducement be made to the younger men to interest them in the Association.

There has been a slight decrease in the membership during the year, which, perhaps, was inevitable after the strenuous efforts which were made for a larger membership, and it is not at all disheartening or discouraging, I think. The annual convention was well attended, and the attendance was especially noticeable in this year when so many conventions were given up and so many of our members were kept away by Government business. The papers, some of them especially, were of marked excellence, and presented by men who have spent their lives in special work, and they form a great contribution to our files and records.

Another notable milestone was the first award of the Dexter Brackett memorial. That is bound, as years go by, to be striven for more and more by practical water-works men. Along that same line it seems to me a strong effort should be made to attract papers and discussions from such men on maintenance problems, as well as from specialists.

The reflection of the high cost of living, of course, is found in the necessity for increasing our dues, and that does not need to be commented upon. But the higher cost of materials, supplies, and labor must be met by increased care in laying out work, better organization and closer coöperation among water-works men, both those who consume supplies and those who sell supplies, the present crisis requiring on the one hand that only such

work be done as is necessary. But, on the other hand, we should realize that no man can tell the future, and therefore it is good judgment, perhaps, not to postpone too much work. We must meet the matter in a broad way, and work that is necessary should go on; and it may be, perhaps, financially easier to do it now, even although it may cost more than formerly. Certainly matters of water purification, metering of supplies, laying out of systems, etc., are necessary for the public health and public welfare, and it seems to me that they should go forward.

This, gentlemen, is all I am going to say to you to-day. I thank you very much for the loyal support I have received on all sides, and particularly from the officers of the Association. My best wish to my successor is that he may receive, as I know he will, the continuation of this support. [*Applause.*]

The next business is the report of the tellers to canvass ballots, and I will call on Mr. Coggeshall.

Mr. R. C. P. Coggeshall submitted the report of the tellers.

REPORT OF TELLERS.

Whole number of ballots	272
Blank	6
President.	
CARLETON E. DAVIS	253
Vice-Presidents.	
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HENRY V. MACKSEY	258
FRANK A. BARBOUR	261
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HENRY R. BUCK	259
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WILLARD KENT	260
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HENRY A. SYMONDS	258

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Respectfully submitted,

R. C. P. COGGESHALL,
GEORGE A. KING,
W. F. SULLIVAN,

Tellers.

The President. It gives me great pleasure to hand over the office of President to one of the ablest water-works executives and managers in the country. I think the New England Water Works Association has honored itself in electing as its President Mr. Carleton E. Davis. [*Loud applause, the members rising.*]

Address of the Newly Elected President.

President Davis. Gentlemen, I deeply appreciate the honor of being asked to serve as the President of this organization. I assume that the Association from time to time desires to go outside of the strictly geographical limits of New England in the selection of its officers, and thereby demonstrate the fact that it is a national organization. New England thought is reflected throughout the entire country, and perhaps the entire world. New England water-works practice is just as widely known, and its influence is just as widely felt, and this is due in a very large measure to this Association and its members.

The Association has had a most enviable record in times of peace in the past thirty-odd years. It is now confronted with the question of what it will do in time of war. That is a question we are all thinking about to-day, — not only what we shall do individually, or what our part in this great struggle will be, but what steps, if any, this Association ought to take in order to get into line.

It is absolutely true that "by their fruits ye shall know them." The question of preparedness is uppermost to-day. We know that the country, in a great many respects, is not prepared to take the part in the war that it should. But that is not the case in the matter of sanitary science, in the matter of camp sanitation, in the matter of water-works equipment and supplies, things which are just as essential as any other feature of the military preparedness of the country. And because the country is so well prepared and has gone forward rapidly along those lines, this Association can take a large measure of credit. The country has called many members of this Association to the training camps to help preserve the lives of millions of young men who are being trained to go abroad, and it has availed itself of the knowledge of biology, chemistry, and other water-works sciences which this Association has brought to the public notice and disseminated generally.

Now, with that record behind it, there is no question that this Association will take the right stand and do the right thing in the coming year, or the coming years, if the war should last. It is possible you may decide to go on practically as you have in the past. It may be possible to carry on these meetings as they have been carried on in the past. But those who know our history will know that, even if there is superficially the same routine of action, there is underneath a very strong — and possibly because of the fact it is not heralded abroad it will be all the stronger — desire on the part of every one of us to do our utmost in helping to win the war.

This Association is noted for its good-fellowship and the hearty coöperation of all its members. Probably none of us at any other time have stood so much in need of good-fellowship, of getting together and telling our difficulties and finding out the other man's experience, as we do at this particular time. We all have our every-day difficulties, and those difficulties have doubtless been enhanced and multiplied many fold because of the war-time conditions.

Water works, of course, are essential — perhaps more essential, in every-day life than any other line of work in the country; and if they are essential in times of peace they are even more essential in times of war. We know this to be the case even though the

general public does not appreciate it, and at this time I feel that we ought to continue these meetings very much as we have continued them in the past, so that we can have the benefit of each other's help and suggestion. Of course that can only be decided from time to time and day to day as events develop, but I think we should at least start off with that view point. [*Applause.*]

Mr. Frank L. Fuller, civil engineer, Boston, Mass., occupied the remainder of the session by an interesting talk on "Porto Rico," illustrated by many stereopticon views.

Adjourned.

February Meeting.

Hotel Brunswick, Boston, Mass.,
February 13, 1918.

Mr. Carleton E. Davis, the President, presiding.

The following members and guests were present:

Honorary Members.

E. C. Brooks. R. C. P. Coggeshall. Frank E. Hall. George A. Stacy. —4.

Members.

L. M. Bancroft.	H. J. Goodale.	J. H. Reynolds.
G. M. Batchelder.	H. A. Hanscom.	H. E. Salmonde.
A. E. Blackmer.	J. L. Howard.	G. A. Sampson.
H. R. Buck.	J. A. Hoy.	P. R. Sanders.
G. A. Carpenter.	Willard Kent.	H. W. Sanderson.
H. H. Chase.	S. E. Killam.	A. L. Sawyer.
F. L. Cole.	P. J. Lucey.	J. E. Sheldon.
W. R. Conard.	F. A. McInnes.	C. W. Sherman.
F. A. Darling.	Hugh McLean.	G. H. Snell.
C. E. Davis.	H. V. Macksey.	H. A. Symonds.
J. M. Diven.	J. H. Mendell.	E. J. Titcomb.
A. O. Doane.	T. A. Peirce.	W. H. Vaughn.
E. D. Eldredge.	H. G. Pillsbury.	R. S. Weston.
R. H. Ellis.	C. R. Preston.	H. F. P. Wilkins. — 46.
F. L. Fuller.	J. F. Ranger.	
Patrick Gear.	C. L. Rice.	

ASSOCIATES.

Bond, H. L., Co., by F. M. Bates.
Builders Iron Foundry, by A. B. Coulters.
Byers, A. M., Company, by H. F. Fiske.
Central Foundry Company, by R. W. Conrow.
Chapman Valve Mfg. Co., by J T. Mulgrew and C. E. Pratt.
Edison Manufacturing Co., by H. L. B. Watson.
Goulds Mfg. Co., by Creed W. Fulton.
Hersey Mfg. Co., by J. H. Smith.
Lead Lined Iron Pipe Co., by T. E. Dwyer.
Mueller, H., Mfg. Co., by C. J. G. Haas.
National Meter Co., by J. G. Lufkin and H. L. Weston.
Neptune Meter Co., by H. H. Kinsey.
Rensselaer Valve Co., by C. L. Brown.
Ross Valve Mfg. Co., by William Ross.
Smith, A. P., Mfg. Co., by F. L. Northrop.
Thomson Meter Co., by E. M. Shedd.
Union Water Meter Co., by H. W. Jacobs and D. K. Otis.
Warren Foundry & Machine Co., by W. F. Woodburn.
Wood & Co., R. D., by Charles R. Wood.
Worthington Pump & Machinery Corp., by Samuel Harrison, W. F. Bird and E. P. Howard. — 25.

GUESTS.

MASSACHUSETTS.

Boston, George A. Caldwell, E. A. Barrier, G. E. Freethy.
Holyoke, James W. Dillon.
Westfield, W. H. Judkins. — 5.

Applications for membership were submitted by the Secretary, from James H. Dillon, Holyoke, Mass., engaged as water commissioner; F. S. Hastings, Verona, Pa., resident chemist and superintendent of filtration, Pennsylvania Water Company; Howard W. Green, Ancon, Canal Zone, sanitary engineer, Miraflores Water Purification Plant, Canal Zone; and Halbert P. Gillette, Chicago, Ill., editor *Engineering and Contracting*.

On motion of Mr. Frank L. Fuller, the Secretary was empowered to cast one ballot in favor of the applicants, and, he having done so, they were declared elected members of the Association.

The report of Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings, submitted at the January meeting, came up for discussion. Upon motion of Mr. Frank A. McInnes, it was voted to grant the privilege of the

floor in the discussion of the report to manufacturers, makers, and others interested in producing pipe. The discussion was participated in by Mr. Charles R. Wood, of R. D. Wood & Co.; Mr. A. B. Coulters, of the Builders Iron Foundry; Mr. William F. Woodman, of the Warren Foundry and Machine Co.; Mr. Frank A. McInnes, Mr. Charles W. Sherman, Mr. J. M. Diven, Mr. W. R. Conard, Mr. Patrick Gear, Mr. Frank L. Fuller, and Mr. H. V. Macksey.

A letter from Mr. Trautwine was also submitted, suggesting certain changes in the proposed specifications.

Mr. Alfred O. Doane, division engineer, Metropolitan Water Works, Boston, Mass., read a paper on "Steam Pumping Engines." Mr. Frank L. Fuller, Mr. J. M. Diven, and Mr. F. H. Hayes, of the Hayes Pump Machinery Company, took part in the discussion.

Mr. Henry A. Symonds submitted the report of the Editor.

Report of the Editor.

February 13, 1918.

To the New England Water Works Association, — I present the following report for Journal of the New England Water Works Association for the year 1917.

The accompanying tabulated statements show, in detail, amount of material in the Journal.

Size of Volume. — The volume is the largest yet published, containing 880 pages. The largest previous volume being number XXIV, of 1910, which contained 808 pages.

Reprints. — The usual fifty reprints of papers have been furnished to authors without charge and additional reprints when desired at the cost of the paper and press work.

Circulation. — The present circulation of the Journal is.

Members, all grades	1 002
Subscribers	86
Exchange	24
Total	1 112

a decrease by 43 from the preceeding year.

Journals have been sent to all advertisers.

Advertisements. — There has been an average of 29 pages of paid advertisements, with an income of $1 702.50, a slight increase over last year.

Pipe Specifications. — During the year the specifications for cast-iron

pipe to the value of $20.20 have been sold. The net gain up to a year ago had been $296.45, so that the total net gain from this source to date is $316.65. These 169 copies of specifications on hand, or $16.90 worth if sold at retail.

The Association has a credit of $3.77 at the Boston Post-Office, being the balance of money deposited for payment of postage upon JOURNAL at pound rates.

The office of editor has been subject to many changes during the last year. Col. Richard K. Hale, after serving the Association as editor very ably since 1909, ending with the issue of the June, 1917, number, took his place with his regiment in the great war.

His successor, William S. Johnson gave the last months of his life to the service of his country and the New England Water Works Association. After the death of Mr. Johnson, Charles Sherman, assisted by Samuel Killam, gave their time freely to the Association and completed the work on the September JOURNAL. The December number was gotten out by the writer, but was delayed, due to his having assumed the office at a late date and finding it necessary to take some time in acquainting himself with the work.

Respectfully submitted,

HENRY A. SYMONDS, *Editor.*

TABLE 1.

STATEMENT OF MATERIAL IN VOLUME XXXI, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1917.

Number.	Date.	Papers.	Proceedings.	Total Text.	Index.	Advertisements.	Cover and Contents.	Insert Plates.	Total.	Total Cuts.
1	March	123	38	161	..	32	4	4	201	9
2	June	149	10	159	..	32	4	8	203	15
3	September	190	32	222	..	31	4	1	258	5
4	December	130	43	173	10	31	4	0	218	0
	Total	592	123	715	10	126	16	13	880	29

NOTE. Owing to the changes in editorship referred to in this report, it has been found impracticable to complete tables No. 2 and 3 with accuracy. They are therefore omitted.

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., January 9, 1918, at 11 o'clock A.M.

Present, President Caleb Mills Saville and members Carleton E. Davis, Samuel E. Killam, William F. Sullivan, Henry A. Symonds, Lewis M. Bancroft, George A. King, and Willard Kent.

On motion of Mr. George A. King, Prof. George C. Whipple, Arthur E. Blackmer, and Alfred D. Flinn were made a committee to recommend the award of the Dexter Brackett Memorial Medal for the year 1917.

Adjourned.

Attest,

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, February 13, 1918, at eleven o'clock A.M.

Present: President Carleton E. Davis and members Samuel E. Killam, Henry V. Macksey, Henry R. Buck, Lewis M. Bancroft, and Willard Kent.

A letter from Mr. George A. King, with reference to the compensation of the Advertising Agent, was presented, and, on motion of Mr. Killam, it was voted that the same be increased to twenty per cent. for the first year on new business secured.

The following applications for membership were received and unanimously recommended therefor:

For members: James H. Dillon, water commissioner, Holyoke, Mass.; Frank S. Hastings, resident chemist and superintendent filtration, Pennsylvania Water Co., Verona, Pa.; Howard W. Green, sanitary engineer, Miraflores Water Purification Plant,

Ancon, C. Z., and Halbert P. Gillette, editor *Engineering and Contracting*, Chicago, Ill.

Voted, that the printing of the membership list be omitted for the current year.

Discussion was had on the subject of place for holding next annual convention, and the Secretary was instructed to write the members of the Executive Committee with reference thereto.

Adjourned.

Attest: WILLARD KENT, *Secretary*.

BOOK REVIEW.

BERTRAM BREWER

"METER RATES FOR WATER WORKS." By Allen Hazen.

Mr. Allen Hazen's latest book, "Meter Rates for Water Works," is fully up to the standard set by that author in previous publications. It is the "direct outgrowth of his service as chairman of the committee on meter rates of the New England Water Works Association."

Naturally, Mr. Hazen supports the findings of that committee in favor of a sliding scale with a three-rate charge, — domestic, intermediate, and manufacturing. Several chapters are devoted to illuminating analyses of the principles involved in the committee's form of rate, supplemented by practical examples.

At the same time the author acknowledged the difficulty in fixing uniform rates for a business where so many individual plants have grown up under their own peculiar conditions, and the consumers have become accustomed to and rather satisfied with rates which are not strictly equitable. Many specific rates are described and criticized constructively, in a laudable attempt to indicate practicable ways by which those in charge could make changes in line with more uniform and equitable methods.

Among other things discussed by Mr. Hazen are minimum rates, service charges, leaks which cannot be accounted for, and leakage in street mains.

There is nothing pedantic or drastic in his suggestions, yet one feels that the author speaks "as one having authority." It should be read by every water-works man. We also wish that every water taker under the metered system would read the chapter on "under registration of meters."

WILLARD KENT, *Sec'y*,

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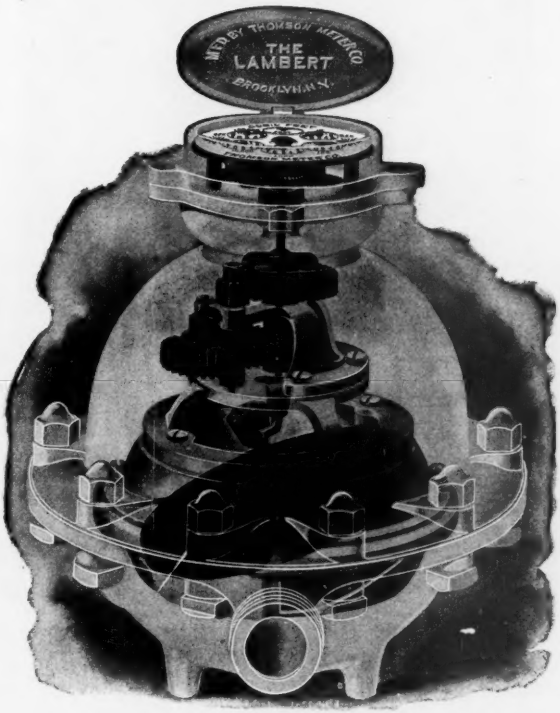

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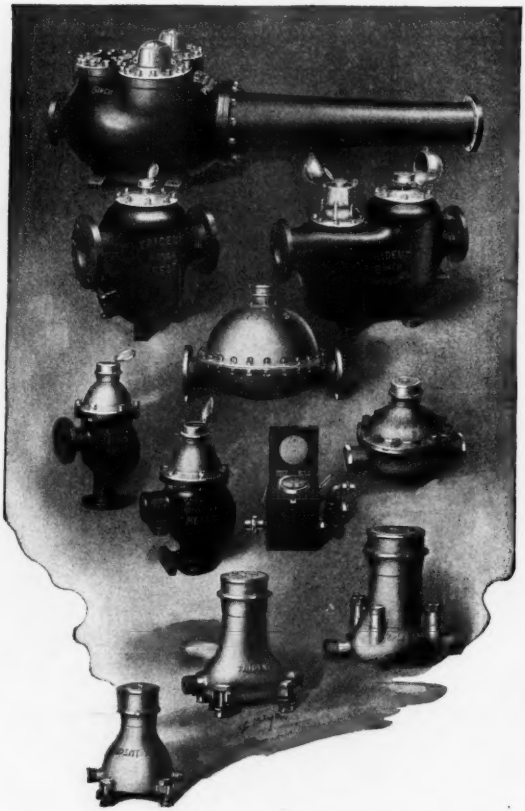

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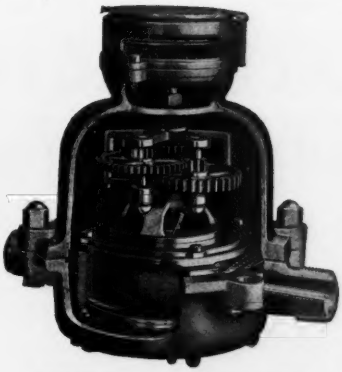

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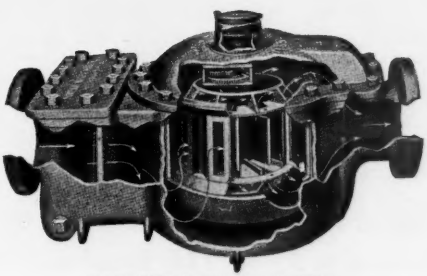

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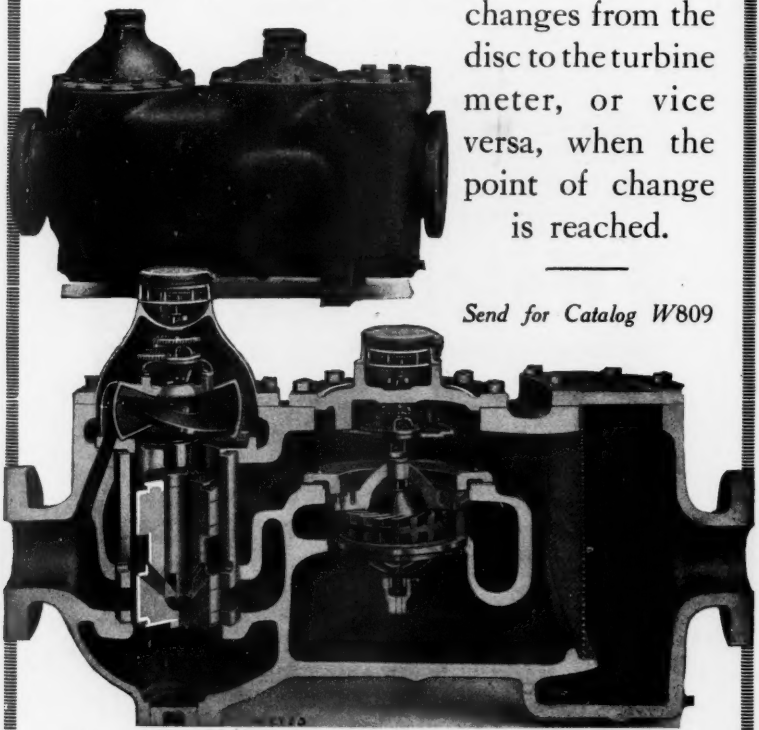

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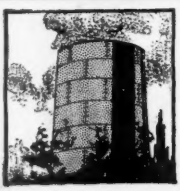

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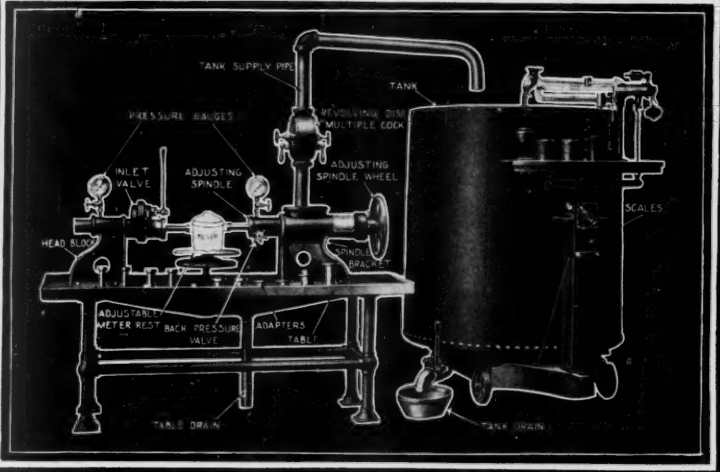

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You can make sure your Department gets full revenue for every gallon of water used—by seeing that all meters are regularly tested for accuracy—with the

Mueller Water Meter Tester

The Mueller will prove exactly what each meter does—will enable you to adjust each meter to absolute accuracy—will save more than its cost year after year. Used and endorsed by leading municipalities. The name Mueller guarantees both Quality and Service.

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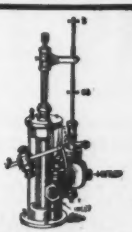

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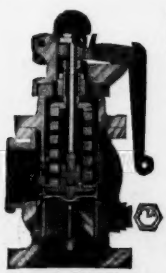

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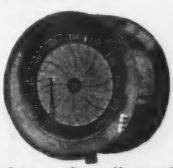

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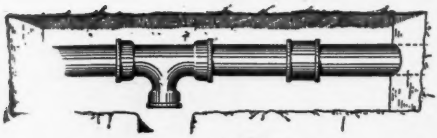
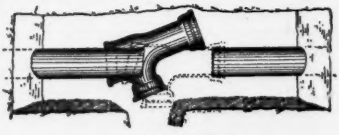
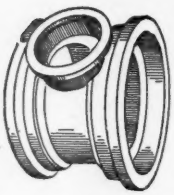


Old Way



Our Way



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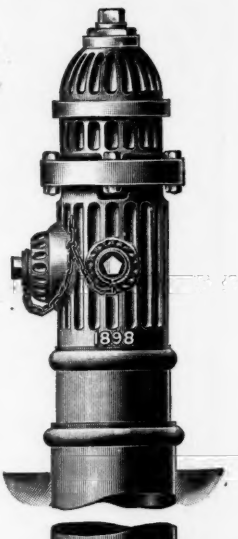

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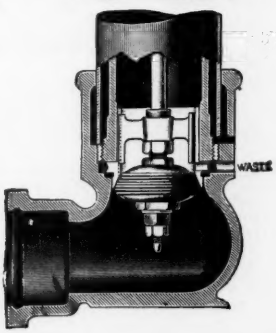
A half century of use has established their reputation as being the most economical, durable and simple hydrant.

Number in use exceeds total of all other makes combined.



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DOUBLE DISK
ANTI-FRICTION
EXTRA WEIGHT, FINISH
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THE LUDLOW VALVE MFG. CO.

MANUFACTURERS OF

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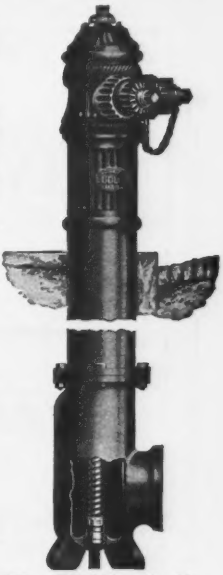
The drip is directly in the bottom of the hydrant and drains perfectly. It is protected by its valve, which never leaves its socket and cannot be clogged.



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THE CHAPMAN VALVE MANUFACTURING COMPANY

Manufacturers of

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Gate Fire Hydrants

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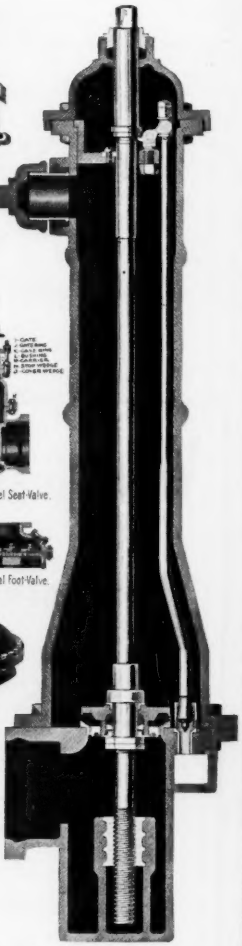
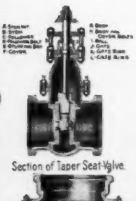
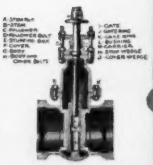




Section of Taper Seat Valve.

Hydrant with Independent Nozzle Cut off.



Section of Parallel Seat Valve.

Section of Vertical Check Valve.

Section of Vertical Foot Valve.

Horizontal Check Valve.

Vertical Foot Valve.

Hydrant with Water Crane Attachment.

Indicator Post.

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MANUFACTURERS
...OF...

CAST IRON PIPE

...AND ..

Special Castings for Water and Gas.
Also Flange Pipe, Street Castings,
Manhole Heads and Covers, etc.

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FOR WATER, GAS, SEWERS, DRAINS, ETC.

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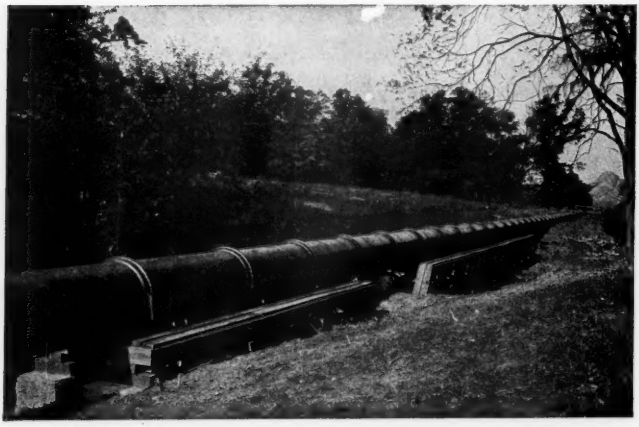

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LEAD WOOL

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For calking pipe joints under the most difficult conditions.

For overhead joints, or in wet places where the use of molten lead is not only impracticable, but dangerous — **LEAD WOOL** may be employed to advantage. It makes perfectly tight joints to withstand the highest pressures, yet sufficiently elastic to admit of considerable sagging or settling of the pipe without causing the joint to leak. The difference in this respect, as compared with the poured joint, is notable.

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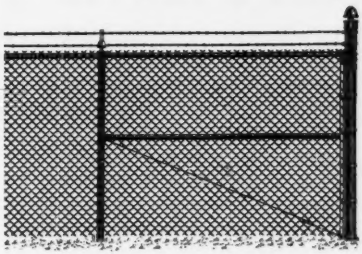

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Twelve Reasons Why

YOU SHOULD USE

Trade "LEADITE" Mark

Registered U. S. Patent Office

FOR

Jointing Water Mains

1. **DURABILITY.** Leadite joints increase in strength with age.
2. **NO CAULKING.** Leadite joints require no caulking, because the Leadite adheres to the pipe, making a water-tight bond.
3. **COMPARATIVE QUANTITIES.** One ton of Leadite is equivalent to four tons of lead.
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7. **TRANSPORTATION.** Considerable freight charges are saved because Leadite is lighter than lead.
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12. **USERS.** Progressive water works all over the country use Leadite.

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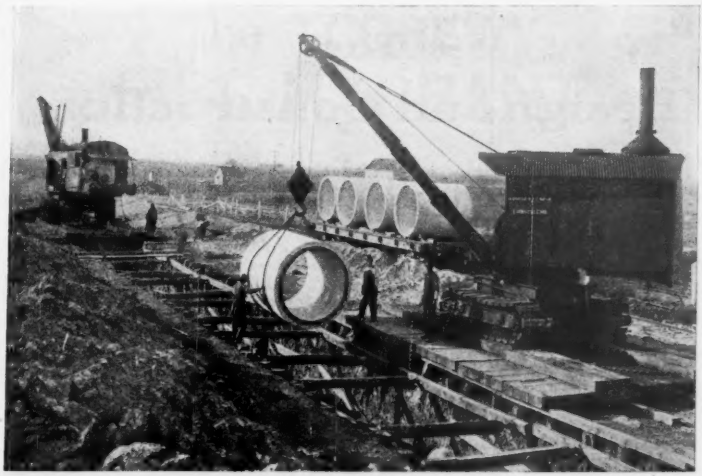
LAND TITLE BUILDING PHILADELPHIA



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Length, 10 miles.

Heads, 45 to 90 feet.

All Pressure Pipes are provided with Copper Expansion Joints.

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We will gladly furnish you with estimates.

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WATER, STEAM, GAS, OIL, ETC.

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Manufacturers of

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JOURNAL

New England Water Works Association,

ORGANIZED JUNE 12, 1882.

APPLICATION FOR MEMBERSHIP.

I, the undersigned, residing at.....

..... *being desirous of admission into the New England Water Works Association, hereby make application for* .....
(resident, non-resident or associate)

.....*membership.*

I am.....*years of age, and I have been engaged in the following named work:*

.....

.....

.....

I will conform to the requirements of membership if elected.

Signed,.....

Address,.....

Dated,.....*191*

Resident members are those residing in New England; all others are non-resident.
Entrance fee is $5.00 for resident and $3.00 for non-resident members.
Annual dues are $4.00 for both resident and non-resident members.